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ABSTRACT

An advanced General Education Program has been designed to prepare an individual with the information concepts, and general knowledge required to successfully pass the American Council on Education's High School General Education Development (GED) Test. The Advanced General Education Program provides comprehensive self-instruction in each of the following areas: (1) Correctness and effectiveness of Expression, (2) Social Studies, (3) Natural Sciences, (4) Interpretation of Literary Materials, and (5) General Mathematics. This document covers positive and negative numbers; states of matter: solid, liquid, gas; properties and measures of matter; energy, matter, theory, and law; and the particles and structure of matter. (CK)

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ADVANCED GENERAL EDUCATION PROGRAM

A HIGH SCHOOL SELF-STUDY PROGRAM

POSITIVE AND NEGATIVE NUMBERS

LEVEL: I
UNIT: 6
LESSON: 1

AC014040

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NOVEMBER 1969

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1.

PREVIEW FRAME

The frames that follow will teach you how to add, subtract, multiply, and divide a new kind of number. Those new numbers will be useful to you in your next lesson on matter and energy.

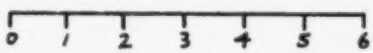
NO RESPONSE REQUIRED

GO ON TO THE NEXT FRAME

2.

Below is a line with numbers marked off on it.

Two numbers have been filled in. You FILL IN the five missing numbers:



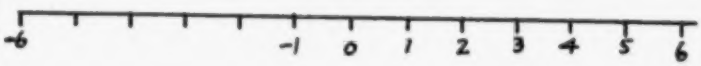
3.

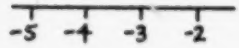
Below is a line with numbers marked off. The numbers shown to the left of zero have a:

☐ + (plus sign) in front
☐ - (minus sign) in front

- (minus sign) in front

Again, FILL IN the missing numbers:





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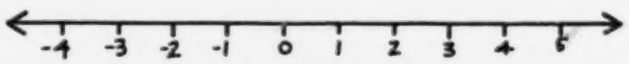


Do the numbers to the left of zero have a plus or minus sign?

☐ plus sign
☐ minus sign

minus sign

5.

Numbers to the left of zero on the line are called "negative" numbers.

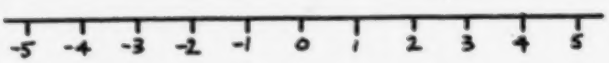
Those to the right of zero are called "positive" numbers.

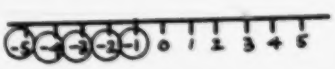
What kind of sign goes in front of a negative number?

☐ +
☐ -

\-

CIRCLE the negative numbers shown below:

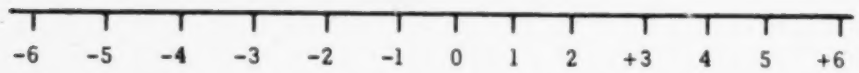




Which number is neither positive nor negative? _____

0

Lesson 1: - Mastery Test



A. $10 + (-5) =$ $\qquad$ $15 + 10 =$

$-15 + (-10) =$ $\qquad$ $-20 + 15 =$

B. $16 - (+8) =$ $\qquad$ $-25 - (+30) =$

$-20 - (-17) =$ $\qquad$ $40 - (+15) =$

C. $16 \times (-2) =$ $\qquad$ $-10 \times 2 =$

$-30 \times (-5) =$ $\qquad$ $20 \times 8 =$

D. $50 \div (-5) =$ $\qquad$ $-100 \div (-10) =$

$200 \div 2 =$ $\qquad$ $-65 \div 5 =$

E. Which of the following numbers is greatest, and which is least?

-10, 1000, 10, -100, -1000, 100

Greatest _____

Least _____

Time completed _____

WHEN YOU HAVE FINISHED THIS TEST, WRITE DOWN THE TIME. THEN TAKE THE LESSON TO YOUR INSTRUCTOR OR HIS ASSISTANT FOR CHECKING. WAIT UNTIL THE LESSON IS APPROVED BEFORE GOING ON TO THE NEXT LESSON.

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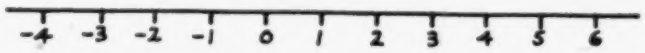
6.

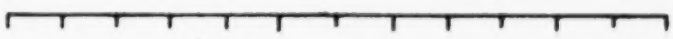


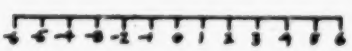
There is one number which is neither positive nor negative. What is that number? _____

0 (zero)

7.

FILL IN the number line below. Put 0 in the center and numbers to the right and left of it.





8.

LOOK AT the number line above.

Look at the positive numbers.

What kinds are shown?

- ☐ some with minus signs
- ☐ some with no signs
- ☐ some with plus signs

some with no signs
some with plus signs

Look at the negative numbers. What kinds are shown?

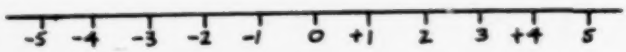
- ☐ all with minus signs
- ☐ all with no signs
- ☐ all with plus signs

all with minus signs

MASTERY TEST

Time started _____

9.



LOOK AT the number line above.

Which do you think is true?

- ☐ Negative numbers are always written with a minus sign.
- ☐ Negative numbers are sometimes written with a minus sign.

Which do you think is true?

- ☐ Positive numbers are always written with a plus sign.
- ☐ Positive numbers are sometimes written with a plus sign.

Negative numbers are always . . .

. . . are sometimes written . . .

10.

Let's review what we now know about + and -.

A plus (+) sign between two numbers (3+2=5) means _____.

add

A minus sign (-) between two numbers (3-2=1) means that the second number is to be _____ from the first.

subtracted

A number to the right of 0 on the number line may be written with or without the plus sign. Example: +3 and 3. These are called _____ numbers.

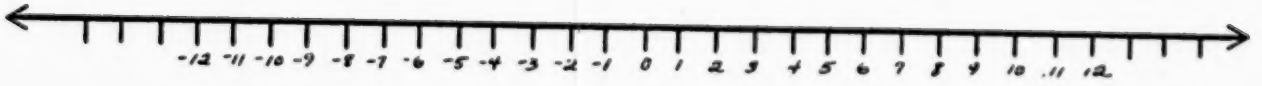
positive

A number to the left of 0 on the number line such as -2 or -6 is called a _____ number.

negative

MATH 1

PANEL 1



11.

What word or words explains what each circled symbol means? (The first two have been done for you as examples.)

$5 \oplus (-7)$	add
$\ominus 6 + 8$	negative number
$12 \ominus (-2)$	subtract
$5 \oplus (-7)$	add
$-6 + \oplus 6$	positive number
$-7 - \ominus (-12)$	negative number

12.

REFER TO PANEL 1 (Page 5).

If you have no money at all, what number on the number line would represent this? _____ 0

If you have five dollars, what number represents this? _____ +5

If you have no money, but you owe someone two dollars, what number represents this? _____ -2

13.

REFER TO PANEL 1

Suppose you have four dollars. Then you get paid twenty dollars. What number would show how much you have altogether? _____ +24

Suppose you have no dollars. You borrow thirty dollars from a friend, what number will show how much you owe? _____ -30

MULTIPLYING AND DIVIDING POSITIVE AND NEGATIVE NUMBERS	if the signs of <u>both</u> numbers to be multiplied or divided are the <u>same</u>, the result (answer) is always <u>positive</u> EXAMPLES: $(+6) \times (+2) = +12$ $(-6) \times (-2) = +12$ $(+6) \div (+2) = +3$ $(-6) \div (-2) = +3$ if the signs of the numbers to be multiplied or divided are <u>different</u>, the result (answer) is always <u>negative</u> EXAMPLES: $(+6) \times (-2) = -12$ $(-6) \times (+2) = -12$ $(+6) \div (-2) = -3$ $(-6) \div (+2) = -3$

14. If you have one hundred dollars in your pocket, what number stands for this? _____ If you have no money and you owe someone one hundred dollars, what number represents this? _____	 +100 -100
15. REFER TO PANEL 1 When do you have more money? ☐ when you have +5 ☐ when you have +10 When do you have less money? ☐ when you owe $2 (-2) ☐ when you owe $4 (-4) As you get more and more money, which way do you count on the number line? ☐ to the left of zero ☐ to the right of zero As you owe more and more money, which way do you count on the number line? ☐ to the left of zero ☐ to the right of zero	 when you have +10 when you owe $4 (-4) to the right of zero to the left of zero

POSITIVE NUMBERS	numbers larger than zero these numbers are written with or without a plus (+) sign EXAMPLES: +3 or 3
NEGATIVE NUMBERS	numbers smaller than zero these numbers are always written with a minus (-) sign EXAMPLES: -3, -6, -23, etc.
ADDING POSITIVE AND NEGATIVE NUMBERS	if a problem has an addition (+) sign in front of a positive number, you add the numbers EXAMPLE: 8 + (+1) = 8 + 1 = 9 if a problem has an addition (+) sign in front of a negative number, you subtract the second number from the first EXAMPLE: 8 + (-1) = 8 - 1 = 7
SUBTRACTING POSITIVE AND NEGATIVE NUMBERS	if a problem has a subtraction (-) sign in front of a negative number, you add the numbers EXAMPLE: 8 - (-1) = 8 + 1 = 9 if a number has a subtraction (-) sign in front of a positive number, you subtract the second number from the first EXAMPLE: 8 - (+1) = 8 - 1 = 7

16.

REFER TO PANEL 1 IF NECESSARY

Which way do you count on the number line as you get more and more money?

☐ left
☐ right

right

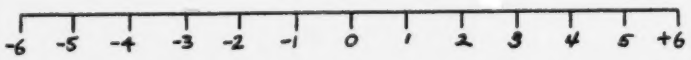
Which way do you count so that the numbers get larger and larger?

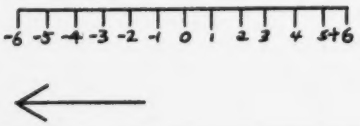
☐ left
☐ right

right

17.

DRAW AN ARROW (⟵ or ⟶) under the number line to show which way you count to show less and less of something.

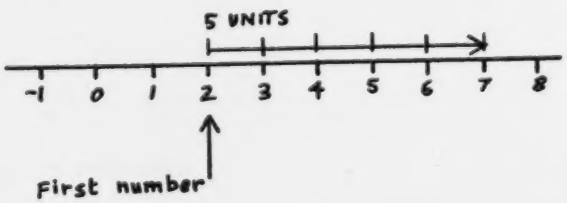


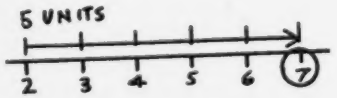


18.

Let's add two positive numbers (2 + 5) using the number line. The first two steps have been done for you.

1. LOCATE the first number (2) on the number line.
2. COUNT 5 units going to the right.
3. CIRCLE the answer on the number line.





51.

REFER TO PANEL 1 IF NECESSARY.

SOLVE, as indicated:

13 + 21 = _____

-76 ÷ -4 = _____

5 x -12 = _____

16 - 10 = _____

-9 x -5 = _____

144 ÷ -12 = _____

19 - (-39) = _____

-15 x -10 = _____

34

19

-60

6

45

-12

58

150

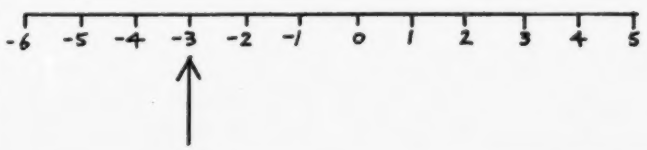
Time completed _____

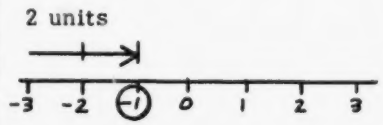
YOU HAVE NOW FINISHED THE FIRST PART OF THIS LESSON. WRITE DOWN THE TIME. THEN, AFTER YOU HAVE REVIEWED THE MAIN IDEAS IN THE FOLLOWING SUMMARY, TAKE THE MASTERY TEST AT THE END OF THE BOOKLET.

19.

COMPLETE the following addition problem using the number line. CIRCLE your answer.

(-3) + 2





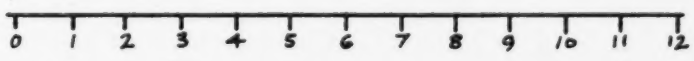
20.

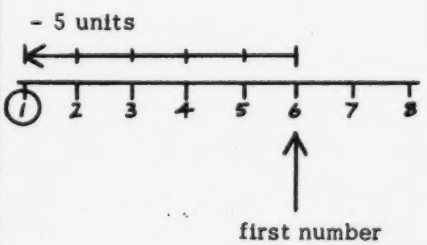
In both of the previous examples the number you were adding was a positive number, and you therefore counted moving to the right. In the next problem you will be adding a negative number.

ADD 6 and -5 by following the step by step instructions given below:

1. LOCATE the first number (6) on the number line.
2. COUNT OFF 5 units going to the left.
3. CIRCLE the answer on the number line.

6 + (-5)





50.

$-10 \div -2 = 5$ $10 \div -2 = -5$

$10 - (-2) = 12$ $10 - (+2) = 8$ $2 - (+10) = -8$

$10 \times (+2) = 20$ $-10 \times (-2) = 20$

ANSWER the questions below by checking either the positive or negative column. (You may check both.) Refer to the problems above as necessary.

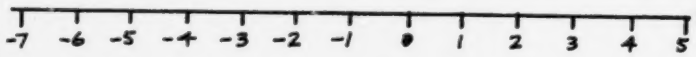
	Positive	Negative		
If you divide a positive number by a negative number is the answer positive or negative?	☐	☐	☐	☒
If you subtract a positive number from another positive number, is the answer positive or negative?	☐	☐	☒	☒
If you subtract a negative number from a positive number is the answer positive or negative?	☐	☐	☒	☐
If both the number you are multiplying by and the number you are multiplying are positive is the answer positive or negative?	☐	☐	☒	☐
If you divide a negative number by a negative number is the answer positive or negative?	☐	☐	☒	☐

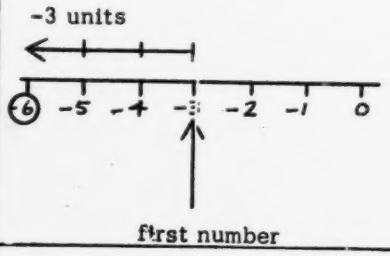
21.

ADD -3 and -3 by following the step-by-step instructions given below:

1. LOCATE the first number (-3) on the number line.
2. COUNT OFF 3 units going to the left.
3. CIRCLE the answer on the number line.

-3 + (-3)

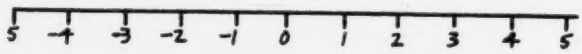


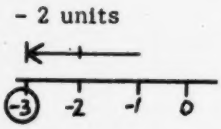


22.

ADD these numbers using the number line:

(-1) + (-2)

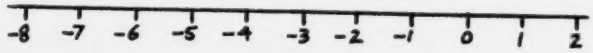


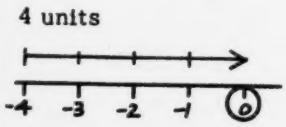


23.

ADD these numbers using the number line:

(-4) + 4





49.

SOLVE, as indicated.

$10 \times (-4) =$ _____	-40
$-40 \div 10 =$ _____	-4
$25 \div (+5) =$ _____	5
$(-10) \div (-2) =$ _____	5
$(-8) \times (-2) =$ _____	16

27

24.

REFER TO PANEL 1

The panel shows a number line extending 12 units to the left and right of 0. USE it to help solve these problems.

To add a positive number to a given number, count off the number to the <u>right</u> of the given number.

To add a negative number to a given number, count off the number to the <u>left</u> of the given number.

ADD the pairs of numbers below. The first two problems have been done for you.

2 + 5 = 7 -2 + (-5) = -7

1 + 2 = _____ -1 + (-2) = _____

3 + 3 = _____ -3 + (-3) = _____

1 + 2 = 3 -1 + (-2) = -3

3 + 3 = 6 -3 + (-3) = -6

25.

REFER TO PANEL 1 to solve these problems.

ADD:

-1 + (-12) = _____ -13

12 + (-7) = _____ 5

-6 + 7 = _____ 1

8 + (-2) = _____ 6

47.

RULE:

If the signs of both numbers to be multiplied or divided are the same, the product or quotient is positive. If the signs are different, the product or quotient is negative.

MULTIPLY or DIVIDE, as indicated, keeping in mind the rule above. The first two have been done for you as examples.

$-4 \times 5 = -20$

$12 \div 2 = 6$

$(-8) \times (-1) =$ _____ 8

$6 \times (-2) =$ _____ -12

$5 \times (-3) =$ _____ -15

$-9 \div (+3) =$ _____ -3

48.

Rule 1: If the signs of both numbers to be multiplied or divided are the same, the answer will be positive.

Rule 2: If the signs are different, the answer will be negative.

MULTIPLY or DIVIDE as indicated:

$9 \times (-2) =$ _____ -18

$-45 \div 9 =$ _____ -5

$+24 \div 6 =$ _____ 4

$(-18) \div (-9) =$ _____ 2

26.

REFER TO PANEL 1 to solve these problems.

ADD:

-5 + (-4) = _____ -9

60 + (-8) = _____ 52

-26 + 9 = _____ -17

-72 + (-14) = _____ -86

27.

You have learned how to add positive and negative numbers. Now we will see what happens when we subtract positive and negative numbers.

LOOK AT these problems:

A. 5 + (-3) = 2
5 - (+3) = 2

B. 5 + (+3) = 8
5 - (-3) = 8

Which of these problems gives the same answer as the problems in Example A above?

☐ 5 - 3
☐ 5 + 3

5 - 3

Which of these problems gives the same answer as the problems in Example B above?

☐ 5 - 3
☐ 5 + 3

5 + 3

46.

Now we will see how to multiply (x) and divide (÷) positive and negative numbers.

LOOK AT these examples:

(+6) x (+2) = +12

(+6) ÷ (+2) = +3

(-6) x (-2) = +12

(-6) ÷ (-2) = +3

(+6) x (-2) = -12

(+6) ÷ (-2) = -3

(-6) x (+2) = -12

(-6) ÷ (+2) = -3

From these examples, see if you can find the rules.

RULES. 1. If the signs of both numbers to be multiplied or divided are the <u>same</u>, the result (product or quotient) is:

☐ negative
☐ positive

positive

2. If the signs of the numbers to be multiplied or divided are different, the result (product or quotient) is:

☐ negative
☐ positive

negative

25

28.

MATCH these problems:

A. 5 + (+3) = 8

B. 5 + (-3) = 2

C. 5 - (+3) = 2

D. 5 - (-3) = 8

1. _____ 5 - 3 = 2

2. _____ 5 + 3 = 8

1. B, C

2. A, D

24

44. REFER TO PANEL 1 The amount of money a man has may also be represented on a number line. If he has $10 in his pocket, that amount could be represented as 10 units to the _____ of zero. On the other hand, if the man has no money at all, the amount would then be represented by _____. Should the man suddenly owe someone else $10, he would have even less money than the nothing in his pocket, that is, his money would then be represented by _____ on the number line.	 right 0 -10
45. If a man has $5 in his pocket and unknowingly has a $10 dinner in a restaurant, he then owes _____ after paying the money he already has. If the man is $10 in debt and then receives another bill for $10, he is then_____ "in the red."	 $5 $20

29.

A. $5 + (-3) = 2$

B. $5 - (+3) = 2$

$5 - 3 = 2$

C. $5 + (+3) = 8$

D. $5 - (-3) = 8$

$5 + 3 = 8$

Problem A above contains:

- ☐ one minus sign
- ☐ one plus sign
- ☐ two minus signs
- ☐ two plus signs

one minus sign
one plus sign

Problem B above contains:

- ☐ one minus sign
- ☐ one plus sign
- ☐ two minus signs
- ☐ two plus signs

one minus sign
one plus sign

Problem C above contains:

- ☐ one minus sign
- ☐ one plus sign
- ☐ two minus signs
- ☐ two plus signs

two plus signs

Problem D above contains:

- ☐ one minus sign
- ☐ one plus sign
- ☐ two minus signs
- ☐ two plus signs

two minus signs

Problems A and B are the same as:

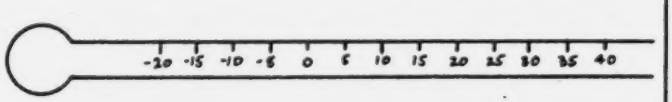
- ☐ $5 - 3 = 2$
- ☐ $5 + 3 = 8$

$5 - 3 = 2$

Problems C and D are the same as:

- ☐ $5 - 3 = 2$
- ☐ $5 + 3 = 8$

$5 + 3 = 8$

42.  The thermometer shown above may be regarded as a number line, with temperatures below 0° similar to the numbers to the _____ of zero on the number line.	left
Therefore, a temperature of 10° below zero would appear as a -10 on the thermometer's number line. Where would a temperature of 10° above zero appear on its number line? _____	10 to the right of 0 (or equivalent response)
We know that a temperature of 40° is warmer than one of 30°. That is, 40° would appear to the _____ of 30° on the number line.	right
Also, a temperature of -5° is warmer than one of -10°.	
That is, -5° appears to the _____ of -10° on the number line.	right
43. REFER TO PANEL 1 Subtracting temperatures is just like subtracting positive and negative numbers on the number line.	
How many degrees more is 30° than 15°? _____	15°
What is the difference in degrees between 20° and -10°? _____	30°
By how much is -5° warmer than -20°? _____	15°

30.

A. $7 + (-4) = 3$
B. $7 - (+4) = 3$ — E. $7 - 4 = 3$

C. $7 + (+4) = 11$
D. $7 - (-4) = 11$ — F. $7 + 4 = 11$

Problem A above has:

- ☐ one minus sign
- ☐ one plus sign
- ☐ two minus signs
- ☐ two plus signs

one minus sign
one plus sign

Problem A can be rewritten as Problem E. Then it would have:

- ☐ one minus sign
- ☐ one plus sign
- ☐ two minus signs
- ☐ two plus signs

one minus sign

Problem B above has:

- ☐ one minus sign
- ☐ one plus sign
- ☐ two minus signs
- ☐ two plus signs

one minus sign
one plus sign

Problem B can be rewritten as Problem E. Then it would have:

- ☐ one minus sign
- ☐ one plus sign
- ☐ two minus signs
- ☐ two plus signs

one minus sign

40. REFER TO PANEL 1 SOLVE, as indicated: -23 + (-20) = _____ 6 + (-33) = _____ -17 - 10 = _____	 -43 -27 -27
41. REFER TO PANEL 1 SOLVE, as indicated: 29 + (-6) = _____ 17 + 26 = _____ 35 - (+9) = _____ -15 + 12 = _____	 23 43 26 -3

31.

A. $7 + (-4) = 3$
B. $7 - (+4) = 3$ E. $7 - 4 = 3$

C. $7 + (+4) = 11$
D. $7 - (-4) = 11$ F. $7 + 4 = 11$

Problem C above has:

- ☐ one minus sign
- ☐ one plus sign
- ☐ two minus signs
- ☐ two plus signs

two plus signs

Problem C can be rewritten as Problem F. Then it would have:

- ☐ one minus sign
- ☐ one plus sign
- ☐ two minus signs
- ☐ two plus signs

one plus sign

Problem D above has:

- ☐ one minus sign
- ☐ one plus sign
- ☐ two minus signs
- ☐ two plus signs

two minus signs

Problem D can be rewritten as Problem F. Then it would have:

- ☐ one minus sign
- ☐ one plus sign
- ☐ two minus signs
- ☐ two plus signs

one plus sign

38. REFER TO PANEL 1 IF NECESSARY SOLVE: 9 + (-3) = _____ 9 + 3 = _____ -9 + 3 = _____ -9 - (-3) = _____	 6 12 -6 -6
39. REFER TO PANEL 1 Now we will do mixed problems of addition and subtraction, using the number line as required. Now, SOLVE these problems as indicated: (The first two have been done for you as examples.) 8 - 4 = 4 8 + 4 = 12 -8 - (-4) = _____ -8 - 4 = _____	 - 4 -12

32.

A. 7 + (-4) = 3
B. 7 - (+4) = 3

E. 7 - 4 = 3

C. 7 + (+4)= 11
D. 7 - (-4)= 11

F. 7 + 4 = 11

LOOK AT the problems above to complete the problems below and WRITE the answer to each problem:

A. 8 + (+1) = _____
B. 8 - (+1) = _____
C. 8 - (-1) = _____
D. 8 + (-1) = _____

8 + 1 = 9
8 - 1 = 7
8 + 1 = 9
8 - 1 = 7

36.

REFER TO PANEL 1

Subtracting any number on the number line is the same as changing its sign and adding.

Perform the following subtractions. (The first two have been done for you.)

$-4 - (-8) = -4 + 8 = 4$

$6 - (-2) = 6 + 2 = 8$

$4 - 7 =$ _____ -3

$5 - (-8) =$ _____ 13

$2 - (-1) =$ _____ 3

37.

REFER TO PANEL 1 IF NECESSARY

SUBTRACT:

$6 - (+4) =$ _____ 2

$5 - (-3) =$ _____ 8

$7 - 8 =$ _____ -1

$5 - (-6) =$ _____ 11

33.

A. 8 + (-1) = 8 - 1 = 7
B. 8 - (+1) = 8 - 1 = 7
C. 8 + (+1) = 8 + 1 = 9
D. 8 - (-1) = 8 + 1 = 9

LOOK AT the problems above to answer the questions below:

If a problem has an addition sign in front of a positive number you:

- ☐ add the numbers
- ☐ subtract the second number from the first

add the numbers

If a problem has an addition sign in front of a negative number you:

- ☐ add the numbers
- ☐ subtract the second number from the first

subtract the second . . .

If a problem has a subtraction sign in front of a negative number you:

- ☐ add the numbers
- ☐ subtract the second number from the first

add the numbers

If a problem has a subtraction sign in front of a positive number you:

- ☐ add the numbers
- ☐ subtract the second number from the first

subtract the second . . .

34.

A. 8 + (-1) = 8 - 1 = 7
B. 8 - (+1) = 8 - 1 = 7
C. 8 + (+1) = 8 + 1 = 9
D. 8 - (-1) = 8 + 1 = 9

LOOK AT the problems above to answer these questions:

1. One minus sign and one plus sign can be rewritten as one _____ sign. — minus

2. Two minus signs can be rewritten as one _____ sign. — plus

3. Two plus signs can be rewritten as one _____ sign. — plus

35.

REFER TO PANEL 1 IF NECESSARY

SOLVE these problems:

11 - (+3) = _____ = _____ — 11 - 3 = 8

11 - (-3) = _____ = _____ — 11 + 3 = 14

11 + (+3) = _____ = _____ — 11 + 3 = 14

11 + (-3) = _____ = _____ — 11 - 3 = 8

PM 431 - 18

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ADVANCED GENERAL EDUCATION PROGRAM

A HIGH SCHOOL SELF-STUDY PROGRAM

STATES OF MATTER: SOLID, LIQUID, GAS
LEVEL: I
UNIT: 6
LESSON: 2

U.S. DEPARTMENT OF LABOR
MANPOWER ADMINISTRATION, JOB CORPS
NOVEMBER 1969

1. PREVIEW FRAME The frames that follow will: a. teach you some important ways of describing the world around you b. prepare you for more complicated lesson units later in the program TAKE TIME TO DO AS WELL AS YOU CAN NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME

2.

Here are 2 cans.

One is filled with cotton, one with iron ore.

The two cans:

- ☐ are the same size
- ☐ are not the same size

The can filled with cotton:

- ☐ is heavier than the one filled with iron ore
- ☐ is lighter than the one filled with iron ore

are the same size

is lighter...

3.

Here are two more cans. One is filled with feathers. The other is filled with marbles.

Which can is bigger?

- ☐ feathers
- ☐ marbles

feathers

Which do you think is heavier?

- ☐ feathers
- ☐ marbles

marbles

4. MATCH the following: (Remember that each state of matter can have more than 1 property)

A. has a definite shape	1. _____ gas
B. has no definite shape	2. _____ liquid
C. has a definite volume	3. _____ solid
D. has no definite volume	

5. In which case will the molecules begin to move faster and farther apart? (CHECK ONE)

a. ☐ when heat is added to a substance

b. ☐ when heat is taken away from a substance

Time completed _____

WHEN YOU HAVE FINISHED THIS TEST, WRITE DOWN THE TIME. THEN TAKE THE LESSON TO YOUR INSTRUCTOR OR HIS ASSISTANT FOR CHECKING. WAIT UNTIL THE LESSON IS APPROVED BEFORE GOING ON TO THE NEXT LESSON.

* U. S. GOVERNMENT PRINTING OFFICE : 1970 O - 389-825

4.

When we talk about how heavy something is, we talk about how much it weighs.

When we say one thing is bigger than another, we are saying the bigger thing takes up more space.

Which takes up more space?

- ☐ a short, thin man
- ☐ a tall, fat man

a tall, fat man

Which weighs more?

- ☐ a short, thin man
- ☐ a tall, fat man

a tall, fat man

Which takes up less space?

- ☐ a rock the size of your fist
- ☐ a very large balloon

a rock the size of your fist

Which weighs less?

- ☐ a rock the size of your fist
- ☐ a very large balloon

a very large balloon

1. CHECK OFF the items below that could be called matter: (You may check more than one answer)

   a. ☐ air

   b. ☐ a candle

   c. ☐ friendliness

   d. ☐ the light from a candle

   e. ☐ a loud noise

   f. ☐ a piece of dust too small to see

2. Are the molecules of ice and the molecules of water vapor molecules of the same substance? (CHECK ONE)

   a. ☐ yes

   b. ☐ no

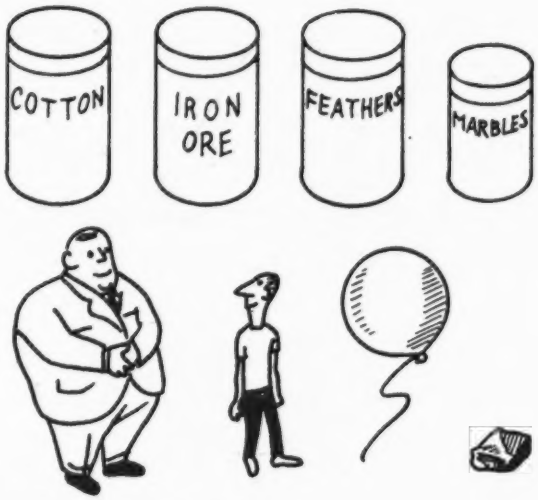
3. In which state of matter do the molecules of a substance hold together most closely and move the least? (CHECK ONE)

   a. ☐ gas

   b. ☐ liquid

   c. ☐ solid

5.



LOOK at the pictures above.

Then MARK the sentences below either true or false:

	TRUE	FALSE	
A big object can weigh more than a little object ----------	____	____	TRUE
A little object can weigh more than a bigger object ----------	____	____	TRUE
Big objects always take up more space than little objects ----------	____	____	TRUE
Big objects always weigh more than little objects ----------	____	____	FALSE
Little objects always take up less space than big objects ----------	____	____	TRUE
Little objects always weigh less than big objects ----------	____	____	FALSE

MASTERY TEST

Time started _____

6. We can identify some things by how much they weigh and by how much space they occupy. In the list below, CHECK the items that have weight and occupy space: ☐ food ☐ happiness ☐ sunlight ☐ the sound of a rifle shot ☐ water ☐ wood	food water wood
7. Everything in the world that has weight and occupies space is called <u>matter</u>. CHECK the things below that you would call matter: ☐ a dream ☐ a mountain ☐ a piece of ice ☐ a radio ☐ a rock ☐ moonlight ☐ music from a radio ☐ sadness ☐ the sound of a friend's voice ☐ your pencil	a mountain a piece of ice a radio a rock your pencil
8. CHECK each of the following that is called matter: ☐ a speck of dust too small to see ☐ air ☐ ice cubes ☐ milk ☐ noise ☐ sorrow	a speck of dust too small to see air ice cubes milk

SOLID	a substance that has a definite shape EXAMPLES: a stone, bread, a baseball bat, etc.
LIQUID	a substance that has no definite shape of its own but that takes the shape of the container that holds it EXAMPLES: water (in a glass), milk (in a bottle), oil (in a tank), etc.
GAS (OR VAPOR)	a substance that has no definite shape and that takes the shape and volume of the container that holds it. EXAMPLE: steam, etc.
VOLUME	the amount of space that something occupies gases have <u>no</u> definite volume solids and liquids have a definite volume
STATES OF MATTER	gas, liquid, and solid are the three states of matter EXAMPLES: ice changes its state of matter when it becomes water; water changes its state of matter when it becomes steam when a substance changes from one state of matter to another, the movement and space between its molecules changes

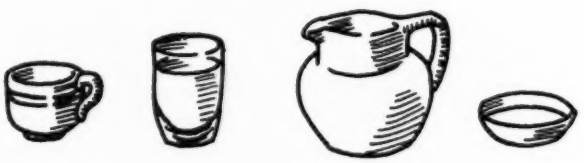
9. Did you say that <u>air</u> and a <u>speck of dust</u> are matter as part of your answer to the last frame? ☐ yes ☐ no	If no, go to frame 10. If yes, go to frame 11.
10. To see that air occupies space, fill a washbasin full of water. Take a glass and turn it upside down and put it in the water. When it gets to the bottom, turn it on its side and watch the bubbles of air rise to the top. Air also has weight. A tire tube that has no air in it weighs less than a tube that is filled with air. But you need a scale that can measure very small amounts to tell this difference. Just as it is difficult to weigh some forms of matter, it is also difficult to see that some forms of matter take up space. For example, you would need a magnifying glass to see a small speck of dust. There are some forms of matter that are too small to see even with the most powerful microscopes. In such cases, scientists rely on other ways to investigate matter. It is only important for you to know now that matter is everything that has weight and occupies space. NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME
11. How would you describe matter? ☐ everything that has weight and occupies space ☐ everything you can hear, see, taste, and smell ☐ everything you think	everything that has weight and...

MATTER	everything in the world that has weight and occupies space EXAMPLES: a rock, a speck of dust, water, air, etc.
SUBSTANCE	all things that are <u>one</u> <u>kind</u> of matter EXAMPLES: water and ice; the wood in a house and the wood in a desk
MOLECULE	the smallest possible part of any substance all molecules of one substance are exactly alike the molecules of one substance are always different from the molecules of another substance
HEAT AND SUBSTANCE	whenever we add heat to a substance, we speed up or <u>increase</u> the movement of its molecules EXAMPLES: the molecules of hot coffee move faster than the molecules of cold coffee; molecules of steam move faster than molecules of water heating a substance also increases the space between the molecules of that substance whenever we cool a substance, we slow down or <u>decrease</u> the movement of its molecules; the molecules also move closer together the movement and the space between the molecules explains why water and steam which are the same substance look and feel different

12.

You know from your own expérience that there are many different kinds of matter in the world. You also know that there are many things which can be referred to as the same kind of matter.

The drawing below shows a cup, a glass, a pitcher, and a small bowl. Each contains some milk.



The cup, the glass, the pitcher, and the small bowl are all filled with:

- ☐ one kind of matter
- ☐ two or more kinds of matter

one kind of matter

56.

When ice melts, it changes from the solid to the liquid state. When water boils, it changes from a liquid to a gas.

Does a change of state change the kind of matter something is?

☐ yes ☐ no

no

57.

NAME the 3 states of matter and give an example of each:

_____

_____

_____

gas (air)

liquid (milk)

solid (ice)

(any order and any similar example)

58.

You now know that the same substance can look and feel differently because of the arrangement and movement of its molecules. But generally, things that look and feel differently are in fact two different kinds of matter.

How do you tell then whether two things are the same or different kinds of matter?

What characteristics do scientists use to distinguish one substance from another?

These questions will be answered in the next lesson.

Time completed _____

YOU HAVE NOW FINISHED THE FIRST PART OF THIS LESSON. WRITE DOWN THE TIME. THEN, AFTER YOU HAVE REVIEWED THE MAIN IDEAS IN THE FOLLOWING SUMMARY, TAKE THE MASTERY TEST AT THE END OF THE BOOKLET.

13.

If two or more things are the same kind of matter, we say that they are the same substance.

For example, we can have two, three, four, or more ice cubes, but they are the same substance. The ice cubes are one kind of matter. Also, water in a faucet is the same substance as an ice cube. Water and ice cubes are one kind of matter.

MATCH the items on the left with those on the right that are the same substance:

A. the milk in a glass	1. _____ milk in a bowl	A
B. the paper of a newspaper printed on Monday	2. _____ a melted ice cube in a glass	C
C. an ice cube in the freezer	3. _____ the paper of a newspaper printed on Wednesday	B
D. sea water from the Pacific Ocean	4. _____ the milk in a pitcher	A
E. the wood in a small oak tree	5. _____ an ice cube in a glass	C
	6. _____ sea water from the Atlantic Ocean	D
	7. _____ the wood in a giant oak tree	E

55.

You can see now that when a substance changes from one state of matter to another, the movement and the space between the molecules of the substance changes. But we still have the same kind of molecules, therefore we still have the same substance.

Milk and frozen milk are:

- ☐ different substances
- ☐ the same substance

the same substance

Milk and frozen milk are composed of:

- ☐ different kinds of molecules
- ☐ the same kind of molecules

the same kind of molecules

Rain and hail are:

- ☐ different substances
- ☐ the same substance

the same substance

Rain and hail are composed of:

- ☐ different kinds of molecules
- ☐ the same kind of molecules

the same kind of molecules

A lake in the summer and a lake in the winter are:

- ☐ different substances
- ☐ the same substance

the same substance

And they are composed of:

- ☐ different kinds of molecules
- ☐ the same kind of molecules

the same kind of molecules

14. When we say two or more things (such as the wood in a house and the wood in a desk) are the same kind of matter, we mean that they: ☐ are the same substance ☐ have the same shape	are the same substance
15. The word substance refers to: ☐ all things that are <u>one</u> kind of matter ☐ <u>two or more</u> kinds of matter	all things that are <u>one</u> . . .

53. Ice changes its <u>state of matter</u> when it becomes water. Water changes its <u>state of matter</u> when it becomes steam. Frozen milk changes its <u>state of matter</u> when it melts. Frozen milk changes its <u>state of matter</u> when it boils into a vapor. LIST the three states of matter and give an example of each: _____ _____ _____	Gas - steam Liquid - milk Solid - ice (any order, and any similar example)
54. In which state of matter are the molecules moving the fastest and the farthest apart? ☐ gas ☐ liquid ☐ solid In which state of matter are the molecules very close together and moving slowly? ☐ gas ☐ liquid ☐ solid	gas solid

16.

Let's talk about one kind of matter that you are familiar with -- water.

You know that when the temperature outdoors is very cold a puddle of water freezes. We call frozen water ice. As it gets warm again, the ice gradually melts. When all the ice has melted, we again refer to the puddle as water.

You can make ice in your freezer. If you leave a tray of water there for a while, it will get hard. But once you take the ice out of the cold area and just leave it on the table, the ice loses its shape and looks like water again.

Would you say that ice and water are:

- ☐ different substances
- ☐ the same substance at different temperatures

the same substance at . . .

51.

LABEL each of the following either GAS, LIQUID, or SOLID:

has a definite shape and a definite volume _____

has a definite volume but no definite shape _____

has no definite shape and no definite volume _____

solid

liquid

gas

52.

The terms gas, liquid, and solid are referred to as the three states of matter.

CHECK OFF the columns that apply to each state of matter:

	VOLUME		SHAPE	
	1	2	3	4
	has no definite volume	has a definite volume	has no definite shape	has a definite shape
Gas				
Liquid				
Solid				

1	2	3	4
X		X	
	X	X	
	X		X

17. When you boil water in a pot, steam comes up from the top of the water. If you hold your hand near the steam, you can feel the heat and the dampness. If you put a lid on top of the pot, the steam will condense on the lid. If you pick up the lid after a few minutes, you can see that the steam has changed back into drops of water. Is steam the same substance as water? ☐ yes ☐ no	yes
18. If ice, water, and steam are the same substances, why do they look and feel differently? In order to answer this, we must take a closer look at matter. NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME

50.

1 ... have a definite volume
2 ... have no definite volume
3 ... have a definite shape
4 ... have no definite shape

USE the phrases above to complete the sentences below:

All gases_____
and _____.

2. have no definite volume
4. have no definite shape
(any order)

All liquids_____
and _____.

1. have a definite volume
4. have no definite shape
(any order)

All solids_____
and _____.

1. have a definite volume
3. have a definite shape
(any order)

19.

When you look at sand very closely, you can see that it is made up of tiny grains. But as small as these grains are, they are not the smallest possible piece of the substance sand.

The smallest possible piece of sand, or any substance, is called a molecule*.

A molecule is such a small part of a substance that even one grain of sand is made up of thousands of molecules.

A drop of water:

- ☐ contains many molecules of water
- ☐ is not made of molecules
- ☐ is the same as a molecule of water

* This word is pronounced "moll'-uh-kule."

contains many molecules of water

49.

LABEL each of the substances below either L for liquid, G for gas, or S for solid:

1.	the air you breathe	G
2.	the cloth your clothes are made of	S
3.	the leather your shoes are made of	S
4.	the meat or fish you eat	S
5.	the pencil you write with	S
6.	the vapor given off when you open a bottle of ammonia	G
7.	the water and milk you drink	L

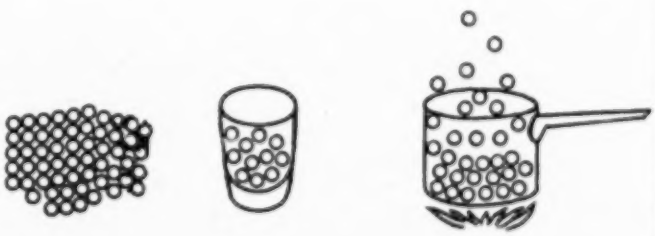
20. All the molecules of one substance are exactly alike, but the molecules of one substance are always different from the molecules of another substance. CHECK the molecules below that are exactly alike. ☐ a molecule of wood ☐ a molecule of water ☐ a molecule of air ☐ a molecule of ice	a molecule of water a molecule of ice
21. The smallest possible part of any substance is called a _____.	molecule
22. Molecules are much too small to be seen. We are going to represent them as small circles, however, so that we can explain how they make ice, water, and steam look and feel differently, although they are the same substance. NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME

47. A gas (or vapor) occupies space. However, the amount of space a gas occupies is difficult to determine because its molecules are so far apart and they are moving so fast. Therefore, we say that a gas: ☐ has a definite volume ☐ has no definite volume	has no definite volume
48. Suppose we put a lid on the pot shown in one of the previous frames. Then the amount of space occupied by the molecules of steam would be determined by the amount of space that is available in the pot. When we say that a gas does not have a definite volume we mean : ☐ that it does not occupy space ☐ that it will assume the volume of its container	that it will assume the volume of its container

23. LOOK at the list of things below. CHECK the ones which state that something is moving. ☐ car ☐ dog ☐ falling leaf ☐ leaf ☐ moving car ☐ rising smoke ☐ running dog ☐ running water ☐ smoke ☐ water	falling leaf moving car rising smoke running dog running water
24. When water boils in a pot, bubbles continually appear and break on the surface. The higher you turn the heat, the faster the bubbles will form and break. When water boils does it move or remain still? ☐ move ☐ remain still	move

46.

LOOK at the drawings below. Drawing A represents the molecules of frozen milk. Drawing B represents the molecules of a glass of milk, and Drawing C represents the molecules of boiling milk.



DRAWING A DRAWING B DRAWING C

Do the molecules of the glass of milk occupy a definite amount of space?

☐ yes ☐ no

yes

Do the molecules of the vapor on top of the pot occupy a definite amount of space?

☐ yes ☐ no

no

Do the molecules of the frozen milk occupy a definite amount of space?

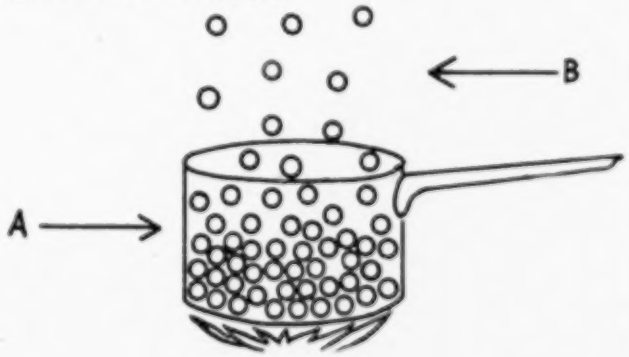
☐ yes ☐ no

yes

25.

We can see the bubbles breaking in boiling water, but we cannot see the movement of the molecules. If we could see the molecules of boiling water, they would look something like the drawing below.

The molecules at the top of the water are moving away from the ones at the bottom.



In the picture Arrow A points to the molecules of the:

- ☐ boiling water
- ☐ steam

boiling water

Arrow B points to the molecules of the:

- ☐ boiling water
- ☐ steam

steam

44.

MATCH the columns below:

A. has a definite shape	1. _____ gas	1. C
B. has no definite shape. Takes the shape of its container	2. _____ liquid	2. B
	3. _____ solid	3. A
C. has no definite shape; does not take the shape of its container		

45.

All matter occupies space.

The amount of space something occupies is called its volume.

Which of these have volume?

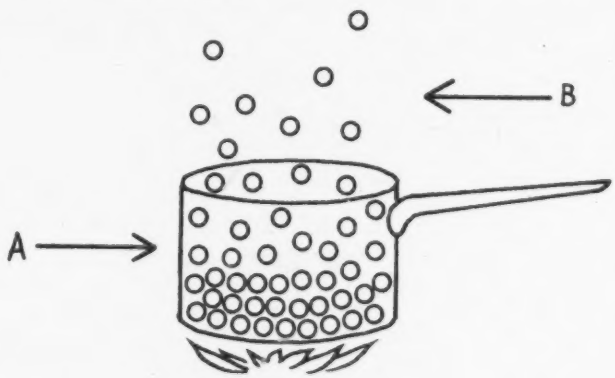
- ☐ gases
- ☐ liquids
- ☐ solids

gases
liquids
solids

26.

When we add heat to water, the molecules begin to move more quickly. They bump into each other and push each other around.

If we continue to add heat, some molecules eventually move so fast that they leave the molecules of the water and fly off into the air as steam.



LOOK at the drawing above.

Arrow A is pointing to the molecules that are:
- ☐ moving faster than those indicated by Arrow B
- ☐ not moving as fast as those indicated by Arrow B

not moving . . .

Arrow B is pointing to the molecules that are:
- ☐ moving faster than those indicated by Arrow A
- ☐ not moving as fast as those indicated by Arrow A

moving faster . . .

Which molecules are closer together?
- ☐ the molecules of steam
- ☐ the molecules of water

the molecules of water

Which molecules are farther apart?
- ☐ the molecules of steam
- ☐ the molecules of water

the molecules of steam

43.

Steam:

- ☐ has a definite shape
- ☐ has no definite shape

has no definite shape

Steam:

- ☐ takes the shape of its container
- ☐ does not take the shape of its container

does not take the shape of its container

Water:

- ☐ has a definite shape
- ☐ has no definite shape

has no definite shape

Water:

- ☐ takes the shape of its container
- ☐ does not take the shape of its container

takes the shape of its container

Ice:

- ☐ has a definite shape
- ☐ has no definite shape

has a definite shape

27.

Whenever we add heat to a substance, we speed up or <u>increase</u> the movement of its molecules.

If we added heat to milk in a pot, the movement of the molecules would:

- ☐ decrease
- ☐ increase
- ☐ slow down
- ☐ speed up

increase

speed up

28.

There are two columns of items listed below.

CHECK the item in which the molecules of the substance would be moving faster. The first has been done for you.

☒	steam	☐	water
☐	cold milk	☐	hot milk
☐	boiling coffee	☐	lukewarm coffee
☐	cold tea	☐	the vapor from a kettle of brewing tea
☐	bacon fat at room temperature	☐	hot bacon fat

steam

hot milk

boiling coffee

the vapor from a kettle . . .

hot bacon fat

42.

Drawing A below represents the molecules of water in a glass, and Drawing B represents the molecules of steam in a glass.

DRAWING A

DRAWING B

Drawing A shows that water:

- ☐ does not take the shape of its container
- ☐ takes the shape of its container

takes the shape of its container

Drawing B shows that steam:

- ☐ does not take the shape of its container
- ☐ takes the shape of its container

does not take the shape of its container

29. When we heat a substance, its molecules: ☐ do not increase their movement ☐ move faster ☐ move slower	move faster
30. The movement and the space between the molecules explains why water and steam which are the same substance look and feel differently. You can put your hands into water (if it is not too hot) and feel the water. You cannot feel the vapor or steam from boiling water in the same way. If you hold your hand above the pot, you can feel the dampness and heat; but you cannot cup the steam in your hands. The molecules are spread too far apart and are moving too fast for you to hold them. NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME

41.

Water has no definite shape of its own. This means that if we melt an ice cube in a glass, the water will take the shape of the glass. If we melt ice in a pitcher, the water will take the shape of the pitcher.

A substance that has no definite shape of its own but takes the shape of the container that holds it is called a <u>liquid</u>.

LABEL each of the following either solid or liquid:

a stone _____ solid
bread _____ solid
milk _____ liquid
orange juice _____ liquid

31.

When we cool water by putting it in the refrigerator or by adding ice to it, we slow down or <u>decrease</u> the movement of its molecules.

The molecules of ice are moving:

- ☐ at the same rate as the molecules of steam
- ☐ faster than the molecules of steam
- ☐ slower than the molecules of steam

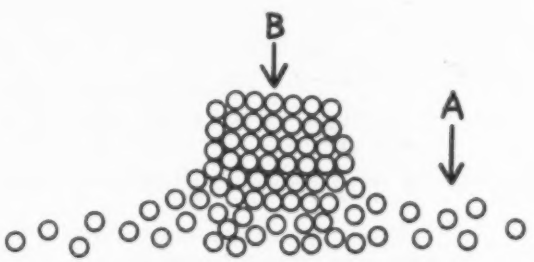
slower than the molecules . . .

38. The shape of a substance, then: ☐ depends on how close its molecules are ☐ depends on how fast or slowly its molecules are moving ☐ does not depend on how close its molecules are ☐ does not depend on how fast or slowly its molecules are moving	depends on how close . . . depends on how fast . . .
39. REVIEW FRAME Molecules of steam: ☐ move faster than molecules of water ☐ move slower than molecules of ice Does steam have a definite shape? ☐ yes ☐ no	move faster than molecules . . . no
40. A substance that has a definite shape is called a <u>solid.</u> Which item below is a solid? (CHECK ONE) ☐ ice ☐ steam ☐ water	ice

32.

Whenever we cool a substance, we decrease the movement of the molecules and generally, the molecules of the substance move closer together.

When a substance is frozen, its molecules are still moving but only very slowly.



The drawing above represents melting ice cream. Arrow A points to the molecules that:

- ☐ have started to move more quickly
- ☐ have very little movement

Arrow B points to the molecules that are:

- ☐ closer together
- ☐ farther apart

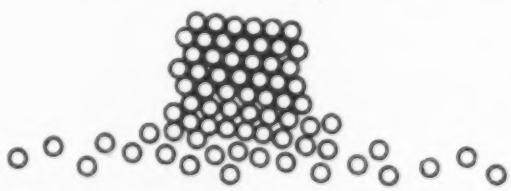
have started to move more quickly

closer together

37.

In a previous frame, we said that when ice melts it loses its shape. You know this from your own experience. If you leave an ice cube on the table, it will melt into a pool of water which has no particular shape.

The drawing below represents the molecules of melting ice cream.



The molecules that are closest together represent the molecules of:

- ☐ the ice cream that is still frozen
- ☐ the ice cream that has melted

the ice cream that is still frozen

The molecules that are farther apart represent the molecules of:

- ☐ the ice cream that is still frozen
- ☐ the ice cream that has melted

the ice cream that has melted

As the molecules move farther apart the ice cream:

- ☐ keeps the same shape
- ☐ loses its shape

loses its shape

77

33.

CHECK the item in the pairs below in which the molecules of the substance would have relatively <u>little</u> movement.

The first has been done for you.

1.	☒ ice cube	☐ water	ice cube
2.	☐ frozen milk	☐ milk	frozen milk
3.	☐ a popsicle	☐ a melted popsicle	a popsicle
4.	☐ a lake on which you can ice skate	☐ a lake in which you can go swimming	. . . on which you can ice skate
5.	☐ hail	☐ rain	hail

36.

When a substance (such as cake) is frozen, is it hard?

- ☐ no
- ☐ yes

yes

When a substance (such as a popsicle) is frozen, does it have a definite shape?

- ☐ no
- ☐ yes

yes

Which of the items listed below are hard?

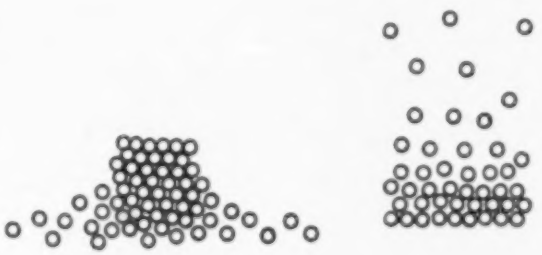
- ☐ a lake on which you can ice skate
- ☐ a lake in which you can swim
- ☐ a melted popsicle
- ☐ hail
- ☐ ice cube
- ☐ milk
- ☐ rain
- ☐ water

a lake on which you can ice . . .

hail
ice cube

34.

The two drawings below represent milk as it is melting and as it is boiling.



A B

The milk is boiling in:

- ☐ Drawing A
- ☐ Drawing B

Drawing B

The milk is melting in:

- ☐ Drawing A
- ☐ Drawing B

Drawing A

The molecules are moving fastest and farthest apart in:

- ☐ Drawing A
- ☐ Drawing B

Drawing B

The molecules are moving the least in:

- ☐ Drawing A
- ☐ Drawing B

Drawing A

35.

The molecules of frozen milk are:

- ☐ closer together than the molecules of lukewarm milk
- ☐ farther apart than the molecules of lukewarm milk
- ☐ moving faster than the molecules of lukewarm milk
- ☐ moving slower than the molecules of lukewarm milk

closer together than . . .

moving slower than . . .

The molecules of lukewarm milk are:

- ☐ closer together than the molecules of boiling milk
- ☐ farther apart than the molecules of boiling milk
- ☐ moving faster than the molecules of boiling milk
- ☐ moving slower than the molecules of boiling milk

closer together than the . . .

moving slower than the . . .

PM 431-19

ED 069986

ADVANCED GENERAL EDUCATION PROGRAM

A HIGH SCHOOL SELF-STUDY PROGRAM

PROPERTIES AND MEASURES OF MATTER
LEVEL: I
UNIT: 6
LESSON: 3

U.S. DEPARTMENT OF LABOR
MANPOWER ADMINISTRATION, JOB CORPS
NOVEMBER 1969

82

U.S. DEPARTMENT OF LABOR
MANPOWER ADMINISTRATION, JOB CORPS
NOVEMBER 1969

5. MATCH the units of measurement on the right with the items they are used to measure on the left:

A. area	1. _____ centimeters
B. length	2. _____ cubic meters
C. volume	3. _____ grams
D. weight	4. _____ kilometers
	5. _____ liters
	6. _____ square centimeters
	7. _____ square meters

6. MATCH the following:

A. ability to dissolve in another substance	1. _____ fluidity
B. ability to flow	2. _____ solubility
C. resistance to flow	3. _____ viscosity

Time completed _____

WHEN YOU HAVE FINISHED THIS TEST, WRITE DOWN THE TIME. THEN TAKE THE LESSON TO YOUR INSTRUCTOR OR HIS ASSISTANT FOR CHECKING. WAIT UNTIL THE LESSON IS APPROVED BEFORE GOING ON TO THE NEXT LESSON.

* U. S. GOVERNMENT PRINTING OFFICE : 1970 O - 369-826

1.

PREVIEW FRAME

In other books in this program you learn about certain qualities that all kinds of matter have. These are called general properties and they include: volume (the amount of space something takes), mass (the amount of matter it contains), weight (the force of attraction between a certain amount of matter and the earth), inertia (the tendency of matter to continue at rest or in motion unless started or stopped by a force).

This booklet is mainly about some of the special properties of matter — hardness, taste, boiling point, and so forth — that we can use to tell one kind of matter from another.

You will also learn about how matter can be measured.

NO RESPONSE REQUIRED

GO ON TO THE NEXT FRAME.

1. CHECK the terms that are special properties of matter

   a. ☐ boiling point

   b. ☐ color

   c. ☐ fluidity

   d. ☐ hardness

   e. ☐ mass

   f. ☐ melting point

   g. ☐ odor

   h. ☐ shape

   i. ☐ solubility

   j. ☐ taste

   k. ☐ volume

   l. ☐ weight

2. Water will pass from the liquid to the gaseous state at 100° C. and 212° F. This means that water has:

   a. ☐ one boiling point that can be measured on 2 different scales

   b. ☐ two boiling points

3. When a substance begins to change from a solid to a liquid state, it has reached its:

   a. ☐ boiling point

   b. ☐ melting point

4. The properties of a substance:

   a. ☐ are different from state to state

   b. ☐ are exactly the same in all 3 states

2.

In order to distinguish (tell the difference) between two different kinds of matter, we can smell them, taste them, look at their color, look at their shape, or feel them.

How do you distinguish between tomato soup and a glass of milk?

- ☐ one is harder than the other
- ☐ they have a different color
- ☐ they have a different odor (smell)
- ☐ they have a different shape
- ☐ they have a different taste

they have a different color
they have a different odor (smell)

they have a different taste

How do you distinguish between a clear rock crystal and a water drop?

- ☐ one is harder than the other
- ☐ they have a different color
- ☐ they have a different odor (smell)
- ☐ they have a different shape
- ☐ they have a different taste

they have a different shape

How do you distinguish between a piece of chocolate candy and a glass of dishwater?

- ☐ one is harder than the other
- ☐ they have a different color
- ☐ they have a different odor (smell)
- ☐ they have a different shape
- ☐ they have a different taste

one is harder than the other
they have a different color
they have a different odor (smell)
they have a different shape
they have a different taste

MASTERY TEST

Time started _____

88

3.

MATCH the substances listed in the left-hand column with the characteristics in the column on the right:

A. clear air	1. _____ is colorless	A, B
B. fresh water	2. _____ has some form or shape	C
C. a bar of steel	3. _____ feels hard when you touch it	C
D. onion soup	4. _____ has an odor (smell)	D (Under certain conditions, for example in a smoky room, air can smell; water too can have a smell if it is dirty, etc.)
	5. _____ is tasteless	A, B (Likewise, under certain conditions air and water may have a taste.)

UNITS OF MEASURE	that which we use to measure area, length, volume, weight, etc.
ENGLISH SYSTEM	the system of measure (units) we use in our daily lives EXAMPLES: inches, feet, quarts, pounds, etc.
METRIC SYSTEM	the system of measure (units) that scientists generally use in their calculations EXAMPLES: centimeters, meters, grams, kilograms, etc.
FAHRENHEIT SCALE	used to measure temperature in the English system EXAMPLE: in the summer, the temperature often reaches as high as 90° F (Fahrenheit)
CENTIGRADE SCALE	used to measure temperature in the metric system EXAMPLE: the boiling point of water is 100° C (Centigrade)

4.

When we refer to the form (or shape), color, odor, taste, and hardness of a substance, we are using the characteristics that scientists call the properties of matter.

MATCH the way in which the properties listed below could be used to describe the kinds of matter in the left-hand column:

A. water vapor	1.___has form	C, F
B. freshly brewed tea	2.___has no form	A,B,D,E
C. a piece of chocolate candy	3.___has an odor	B,C,D,E
D. perfume	4.___has no odor	A,F
E. the air in a bakery	5.___has a taste	B,C , D*
F. a plate	6.___has no taste	A,D,F
	7.___has a certain color	B,C,D,F
	8.___has no color	A,E
	9.___is hard	C,F
	10.___is not hard	A,B,D,E

*Perfume may have a taste, but we do not taste perfume; nor do we use the property taste to distinguish one perfume from another perfume.

PROPERTIES OF MATTER	smell, taste, color, shape, hardness, boiling point, melting point, solubility, fluidity and viscosity are all properties of matter the properties of a substance often change when matter changes its state; but they do not always change
A. BOILING POINT	temperature at which a substance begins to change from a liquid to a gas EXAMPLE: the boiling point of water is 212° F (Fahrenheit)
B. MELTING POINT	temperature at which a substance begins to change from a solid to a liquid EXAMPLE: the melting point of water (ice) is 32° F
C. SOLUBLE OR SOLUBILITY	the ability of one substance to dissolve in another; if one substance can dissolve in another substance, we say that the substance is soluble EXAMPLE: sugar is soluble in hot coffee
D. FLUIDITY	the ability of a substance to flow EXAMPLES: water flows in a river; air flows from room to room
E. VISCOSITY	the resistance of a substance to flowing EXAMPLE: frozen lemonade has a greater viscosity than liquid lemonade different kinds of matter can be distinguished by their properties EXAMPLES: a rock is harder than water; salt tastes different from sugar; etc.

5. CHECK the properties of matter that you would use to describe the difference between a freshly baked lemon cake and a loaf of stale white bread: ☐ color ☐ hardness ☐ odor ☐ shape ☐ taste	color hardness odor shape taste
6. Color, hardness, odor, shape, and taste are 5: ☐ states of matter ☐ properties of matter Gas, liquid, and solid are the 3: ☐ states of matter ☐ properties of matter	properties of matter states of matter
7. PICK OUT 5 properties of matter from the list of items below: ☐ color ☐ gas ☐ hardness ☐ liquid ☐ matter ☐ odor ☐ shape ☐ space ☐ taste ☐ weight	color hardness odor shape taste

51.

We measure the amount of space a substance occupies in terms of volume.

We measure the amount of matter a substance has in terms of weight.

Another word which refers to the amount of matter a substance has is mass*.

The mass of a substance is also expressed in grams and pounds.

The mass of a substance is another word for

- ☐ volume
- ☐ weight

*The difference between mass and weight will be explained in a later lesson. For now, mass and weight will be used interchangeably.

→ weight

52.

The mass of a substance refers to the:

- ☐ amount of matter a substance has
- ☐ amount of space a substance occupies.

amount of matter . . .

53.

Volume refers to the amount of _____ a substance occupies.

space

Weight and mass refer to the amount of _____ a substance has.

matter

Time completed _____

YOU HAVE NOW FINISHED THE FIRST PART OF THIS LESSON. WRITE DOWN THE TIME. THEN, AFTER YOU HAVE REVIEWED THE MAIN IDEAS IN THE FOLLOWING SUMMARY, TAKE THE MASTERY TEST AT THE END OF THE BOOKLET.

8. Next to each pair of items listed below, WRITE one of the five properties of matter that you could use to distinguish one substance from another: A. the top of a desk and a pillow _____ B. fried bacon and a glass of water _____ C. two books in a library _____ D. a steak and strawberry shortcake _____ E. a baseball and a bat _____	color hardness shape (any 1) color hardness odor shape taste (any 1) color shape (possibly hardness if one has a soft cover) (any 1) color hardness odor shape taste (any 1) color hardness shape (any 1)
9. Let's take a look and see what happens to the properties of a substance when it changes state. NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME

49. REFER TO PANEL 1 IF NECESSARY PUT L before the items below that are a measure of length. PUT A before the items that are a measure of area. PUT V before the items that are a measure of volume. PUT W before the items that are a measure of weight. _____ meters _____ miles _____ ounces _____ pounds _____ quarts _____ square centimeters _____ square inches _____ square yards _____ yards	

10.

CHECK OFF the properties that apply to each of the states of matter of water:

	1. Has shape	2. Is odorless	3. Is tasteless	4. Is colorless	5. Feels hard	1	2	3	4	5
Steam	☐	☐	☐	☐	☐	☐	☒	☒	☒	☐
Water	☐	☐	☐	☐	☐	☐	☒	☒	☒	☐
Ice	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒

11.

Now CHECK OFF the properties that apply to each of the states of matter of coffee:

	1. Has shape	2. Has an odor	3. Has taste	4. Has color	5. Feels hard	1	2	3	4	5
Vapor (Gas)	☐	☐	☐	☐	☐	☐	☒	☒	☐	☐
Liquid	☐	☐	☐	☐	☐	☐	☒	☒	☒	☐
Solid	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒

48.

REFER TO PANEL 1 IF NECESSARY

PUT L before the items below that are a measure of length.

PUT A before the items that are a measure of area.

PUT V before the items that are a measure of volume.

PUT W before the items that are a measure of weight.

_____	centimeters	L
_____	cubic centimeters	V
_____	cubic inches	V
_____	grams	W
_____	inches	L
_____	kilograms	W
_____	kilometers	L
_____	liters	V

12. Now CHECK each sentence true or false: Some of the properties of a substance may change when the substance is in a different state of matter. ☐ True ☐ False All of the properties that a substance has are different when a substance changes from the solid to the liquid state or the liquid to the gaseous state. ☐ True ☐ False	 True False
13. FILL IN the blanks below with the five properties of matter. The first letter of each word is already given. C _____ H _____ O _____ S _____ T _____	 color hardness odor shape taste

46.

REFER TO PANEL 1

LOOK AT the bottom of the panel under the heading "Weight."

What measures for weight are there in the English System?

- ☐ grams
- ☐ kilograms
- ☐ ounces
- ☐ pounds

ounces
pounds

47.

An ounce is equal to about 28 grams. Which weighs more?

- ☐ 1 ounce
- ☐ 1 gram

1 ounce

One kilogram is equal to about 2 pounds. If something weighs 4 pounds, how many kilograms will it weigh?

- ☐ 1
- ☐ 2
- ☐ 4
- ☐ 8

2

14. NAME the five properties of matter that you have learned:	color hardness odor shape taste (any order)
15. REVIEW FRAME You have learned in previous frames that matter can exist in three states. What are these states?	gas solid liquid (any order)
16. You have read in previous frames, and you know from your own experience, that matter can change from one state to another state. When water is frozen, it changes from a _____ state to a _____ state. When water is boiled, it changes from a _____ state to a _____ state.	liquid solid liquid gaseous

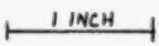
45.

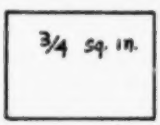
REFER TO PANEL 1

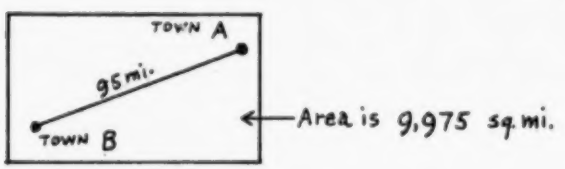
The pictures below are labeled with the unit of measurement that is used in the English System.

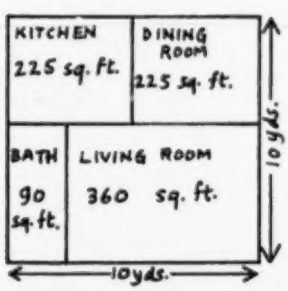
MATCH the pictures with the appropriate unit of measurement from the Metric System:

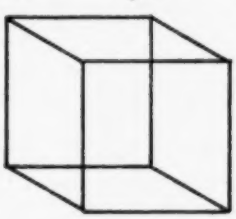
A.

B. 

C. 

D. 

E. 

F. 

1. _____ centimeter
2. _____ cubic centimeter
3. _____ kilometer
4. _____ liter
5. _____ square meter
6. _____ square centimeter
7. _____ square kilometer

1. B
2. F
3. D
4. A
5. E
6. C
7. D

17.

Shown above is a piece of melting ice, and its temperature; and steam from boiling water and its temperature.

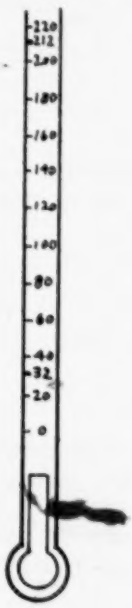
In the picture, F. refers to the Fahrenheit scale. This is used to measure:

- ☐ temperature
- ☐ volume

temperature

LOOK at the diagram above. Now CIRCLE the temperatures on the thermometer below at which water:

1. changes from the liquid to the gaseous state
2. changes from the solid to the liquid state



212

32

44.

REFER TO PANEL 1

A centimeter is about 1/3 of an inch. In other words, three centimeters just about equal an inch.

A meter is about 3 inches longer than a yard. A yard is 36 inches long. One meter is about how long?

_____

about 39 inches

A kilometer is a little over 1/2 of a mile. About how many kilometers equal 1 mile:

_____

about 2

USING the information given above, and by REFERRING TO THE PANEL, MATCH the following:

A.

B.

C.

1. _____ centimeter
2. _____ cubic centimeter
3. _____ square centimeter

1. B
2. C
3. A

44a.

FOOTNOTE FRAME

It is not important for you to memorize how many centimeters make up an inch. It is important, however, for you to know that both the centimeter, and the inch, are used to measure length.

NO RESPONSE REQUIRED

GO ON TO THE NEXT FRAME

18.

When a substance reaches a temperature at which it begins to change from a liquid to a gas, we say it has reached its boiling point.

When a substance reaches a temperature at which it starts to change from a solid to a liquid, we say it has reached its melting point.

What is the boiling point of water?

- ☐ 0° F.
- ☐ 32° F.
- ☐ 100° F.
- ☐ 212° F.

212° F.

What is the melting point of water?

- ☐ 0° F.
- ☐ 32° F.
- ☐ 100° F.
- ☐ 212° F.

32° F.

42. REFER TO PANEL 1 The units of measurement that you know best, such as inches, miles, and quarts, are shown on the panel under the words: ☐ English System ☐ Metric System	English System
43. REFER TO PANEL 1 The "English System" of measurement is the one that we use in our daily lives. However, scientists generally use another system called the "Metric System." The Metric System of measurement, as shown on the panel, gives measures for: ☐ area ☐ length ☐ time ☐ volume ☐ weight	area length volume weight

19.

When we boil water, we:

- ☐ add heat
- ☐ take heat away

add heat

Thus, a substance will reach its boiling point at a temperature that is:

- ☐ colder than the temperature of its freezing point
- ☐ hotter than the temperature of its freezing point

hotter than the temperature . . .

Temperatures below zero are:

- ☐ colder than temperatures above zero
- ☐ hotter than temperatures above zero

colder than temperatures . . .

A temperature of -132° F.* is:

- ☐ colder than a temperature of -32° F.
- ☐ hotter than a temperature of -32° F.

colder than a temperature . . .

*A minus sign in front of a temperature indicates that the temperature is below zero.

40.

REFER TO PANEL 1 (Page 22).

The Panel lists some of the units we use to measure:

- ☐ area
- ☐ hardness
- ☐ length
- ☐ taste
- ☐ viscosity
- ☐ volume
- ☐ weight

area

length

volume
weight

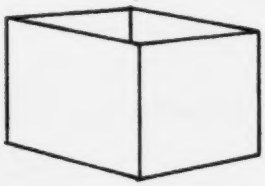
41.

REFER TO PANEL 1

MATCH the following to show what we would measure of a straight line, a flat surface, and a box:

A. _____

B.

C. 

1. _____ area
2. _____ length
3. _____ volume
4. _____ weight

1. B
2. A
3. C
4. C

BASIC MATTER 2

PANEL 1

LENGTH

METRIC SYSTEM	ENGLISH SYSTEM
Centimeters	Inches
Meters	Yards
Kilometers	Miles

AREA

Square Centimeters	Square Inches
Square Meters	Square Yards
Square Kilometers	Square Miles

VOLUME

Cubic Centimeters	Cubic Inches
Liters	Quarts

WEIGHT

Grams	Ounces
Kilograms	Pounds

37. The following frames will discuss the terms that are used when we measure matter. Some of these you are familiar with already; others may be new to you. NO RESPONSE REQUIRED	 GO ON TO THE NEXT FRAME
38. You probably know how long a <u>yard</u> is and how long a <u>mile</u> is. Each of these is called a <u>unit</u> of measurement. WRITE IN the appropriate units of measurement in the blanks below: It is about 3,000 _____ across the United States. A clothes line is about 10 _____ long.	 miles yards
39. You are probably also familiar with the units of <u>quart</u> and <u>pound</u>. MATCH these units with what they are used to measure: A. how much something weighs B. the volume of liquids 1. _____ pound 2. _____ quart	 1. A 2. B

20.

Different substances have different boiling points and melting points. The boiling and melting points for some different substances are listed below.

For each kind of matter, LABEL one temperature MP for melting point and one temperature BP for boiling point:

MERCURY

675° F. ____ BP

-37° F. ____ MP

IRON

4955° F. ____ BP

2795° F. ____ MP

OXYGEN

-426°F. ____ MP

-361° F. ____ BP

34.

Below is a list of some substances. For each one, CHECK the appropriate column, i.e., "Fluidity" or "Viscosity."

	Fluidity	Viscosity	Fluidity	Viscosity
cold grease	☐	☐		x
frozen orange juice	☐	☐		x
lemonade	☐	☐	x	
tea	☐	☐	x	

35.

MATCH the following:

A. Ability to dissolve	1. _____	fluidity	B
B. Flows or pours easily	2. _____	solubility	A
C. Resistance to flow	3. _____	viscosity	C

36.

Fluidity, and its opposite, viscosity, is one more way to describe the difference between kinds of matter.

READ the list below and CHECK the items that are <u>properties</u> of matter:

- ☐ gas, liquid, and solid states
- ☐ melting and boiling points
- ☐ odor, taste, color, hardness, and shape
- ☐ solubility, fluidity, and viscosity
- ☐ weight

melting and boiling points
odor, taste, color, hardness . . .
solubility, fluidity, and . . .

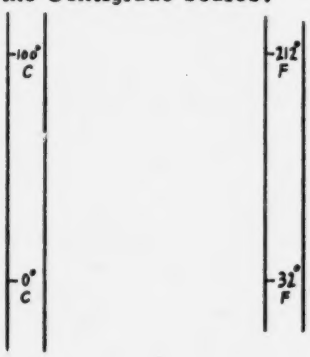
112

21.

Notice that the melting points and boiling points of the substances listed in the previous frame are large numbers. There is another scale, called the Centigrade scale. Scientists usually use this scale for measuring temperatures because it is easier to perform calculations with the Centigrade scale.

However, you are probably more familiar with the Fahrenheit scale since it is used to measure the temperature of our atmosphere, the inside of our stoves and refrigerators, etc.

The drawing below shows the relationship between the Fahrenheit and the Centigrade scales.



At what temperature does water boil on the Centigrade scale? _____

100° C.

At what temperature does ice melt on the Centigrade scale? _____

0° C.

32. The ability to flow is called <u>fluidity</u>. The resistance of a substance to flowing is called <u>viscosity</u>. Which has more fluidity? ☐ plain water ☐ water mixed with flour Which has more viscosity? ☐ plain water ☐ water mixed with flour	 plain water water mixed with flour
33. Fluidity = ability to flow. Viscosity = resistance to flow. Which has greater viscosity? ☐ cold molasses ☐ melted butter Which has greater fluidity? ☐ gasoline ☐ tar If one substance has greater fluidity than another substance, it will flow: ☐ faster ☐ more slowly	 cold molasses gasoline faster

22.

The temperatures below on the left represent the melting point and boiling point of water on one scale, and the temperatures on the right represent the melting point and boiling point of water on another scale.

WATER

MP 0°	MP 32°
BP 100°	BP 212°

The temperatures on the left are from which scale?

- ☐ Centigrade
- ☐ Fahrenheit

The temperatures on the right are from which scale?

- ☐ Centigrade
- ☐ Fahrenheit

Centigrade

Fahrenheit

23.

Which scale is used to tell the temperature of the air in a room? _____

Which scale do scientists usually use in their calculations? _____

Fahrenheit

Centigrade

24.

Different kinds of matter have:

- ☐ different melting and boiling points
- ☐ the same melting and boiling points

different melting and boiling . . .

29. A sugar cube readily dissolves in many liquids, but a substance such as wood does not. Would you say that solubility is one more way we can tell the difference between kinds of matter: ☐ no ☐ yes	yes
30. You have just learned another property of matter. The property refers to the ability of a substance to dissolve. This property of matter is called _____.	solubility
31. The property you will now be introduced to refers to the ease with which a substance will flow. You are probably used to thinking that only liquids flow. However, gases can flow also. Air, for example, is a gas, and we can say that air flows from one room to another. Which substances below have the ability to flow? ☐ car exhaust fumes ☐ bread ☐ honey ☐ ice ☐ milk	car exhaust fumes honey milk

25.

REVIEW FRAME

Since the boiling and melting points of a substance can be used to distinguish one kind of matter from another, they are also called properties of matter.

CHECK the 7 properties of matter that you have studied so far.

- ☐ boiling point
- ☐ color
- ☐ hardness
- ☐ melting point
- ☐ occupies a definite space
- ☐ odor
- ☐ shape
- ☐ taste
- ☐ volume
- ☐ weight

boiling point
color
hardness
melting point

odor
shape
taste

26.

Color, odor, taste, shape, and hardness are properties of matter.

NAME two more properties of matter:

_____

_____

boiling point

melting point
(any order)

27.

Many times each day we mix one kind of matter with another. Sometimes the things we are trying to mix separate as soon as we stop stirring them. For example, hot bacon grease will settle on the top of water if we stop stirring.

If two substances are mixed evenly throughout (even after we have stopped stirring) we say that one substance has dissolved in the other. For example, after we stir sugar into hot coffee, the sugar stays dissolved until the coffee gets cold.

CHECK the mixtures below where one substance would dissolve in another substance:

- ☐ hot water and flour
- ☐ milk and marbles
- ☐ oil and water
- ☐ salt and coffee
- ☐ water and Alka-Seltzer
- ☐ water and silverware

hot water and flour

salt and coffee
water and Alka-Seltzer

28.

If one substance can dissolve in another substance, we say that the substance is <u>soluble</u>.

<u>Solubility</u> is the <u>ability</u> of one substance to dissolve in another.

Which of the items below are examples of solubility?

- ☐ chlorine and the water in a swimming pool
- ☐ a hamburger with ketchup
- ☐ hot chocolate and sugar

chlorine and the water . . .

hot chocolate and sugar

PM 431 - 20

ED 069986

ADVANCED GENERAL EDUCATION PROGRAM

A HIGH SCHOOL SELF-STUDY PROGRAM

ENERGY, MATTER, THEORY AND LAW

LEVEL: I

UNIT: 6

LESSON: 4

U.S. DEPARTMENT OF LABOR
MANPOWER ADMINISTRATION, JOB CORPS
NOVEMBER 1969

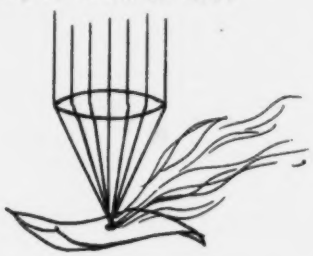
U.S. DEPARTMENT OF LABOR
MANPOWER ADMINISTRATION, JOB CORPS
NOVEMBER 1969

1. PREVIEW FRAME You already know that matter can be changed from one state to another, and that changing the state of a substance does not change it into a different substance. In this lesson, you will see how substances are changed into different substances, and the importance of this kind of change. NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME
2. The molecules of which state of matter are moving the fastest? ☐ gas ☐ liquid ☐ solid	gas
The molecules of which state of matter are moving the slowest? ☐ gas ☐ liquid ☐ solid	solid
The movement of a substance's molecules <u>increases</u> when we: ☐ add heat ☐ take away heat	add heat
The movement of a substance's molecules <u>decreases</u> when we: ☐ add heat ☐ take away heat	take away heat

3. That which has the ability to move matter is called <u>energy</u>. Heat is an example of energy because: ☐ it increases the movement of molecules ☐ it decreases the movement of molecules	it increases the movement of molecules
4. You have probably read or heard of incidents in which a loud sound has caused glass to shatter. For example, when the atom bomb was tested in New Mexico, there were reports that the sound of the blast broke windows many miles away. Now you know that glass is composed of molecules and you can understand what happens: the sound causes the molecules of the glass to move; as they move out of place, the glass shatters. Sound: ☐ is a form of energy ☐ does not have the ability to move matter ☐ has the ability to move matter	is a form of energy has the ability to move matter
5. Sound and heat: ☐ do not have the ability to move matter ☐ have the ability to move matter Sound and heat are: ☐ forms of energy ☐ forms of matter	have the ability to move matter forms of energy

5a.

Light can also put matter into motion. You have probably heard of sunlight and a magnifying glass being used to start a fire. A magnifying glass causes the rays of sunlight to bend so that they form one very strong ray (see the drawing below). This strong ray produces heat which will eventually cause a substance (such as paper or dried leaves) to catch on fire.



CHECK the forms of energy in the list below:

- ☐ gas
- ☐ heat
- ☐ light
- ☐ a magnifying glass
- ☐ sound

heat
light

sound

4. LABEL the changes below CC if they represent a chemical change, and PC if they represent a physical change:

   a. _____ a burnt marshmallow

   b. _____ the manufacture of bread crumbs from bread

   c. _____ the manufacture of sawdust from wood

   d. _____ the melting of butter

   e. _____ a tree set on fire by lightning

5. Which of the following statement(s) is/are scientific laws?

   a. ☐ Matter can be converted into energy.

   b. ☐ Sometimes all of the properties of a substance are altered in a physical change.

   c. ☐ One kind of matter can never be changed into another kind of matter.

Time completed _____

WHEN YOU HAVE FINISHED THIS TEST, WRITE DOWN THE TIME. THEN TAKE THE LESSON TO YOUR INSTRUCTOR OR HIS ASSISTANT FOR CHECKING. WAIT UNTIL THE LESSON IS APPROVED BEFORE GOING ON TO THE NEXT LESSON.

* U. S. GOVERNMENT PRINTING OFFICE : 1970 O - 389-827

6. You know that we can use electricity to produce sound and heat. The phonograph and electric stove are examples of electricity putting matter into motion. Is electricity a form of energy? ☐ no ☐ yes	 yes
7. The forms of energy you have just learned (heat, sound, light, and electricity) can be interchanged. Exactly what happens when each form of energy is changed, or converted, to another form of energy will be explained in later lessons. You already know that electricity can produce sound, heat, and light. If we let H represent heat L represent light S represent sound, and E represent electricity; we can use a shorthand method to say that electricity can be changed to heat: E→H CHECK the shorthand statements below that are true: ☐ E→S ☐ L→H ☐ E→L	 E→S L→H E→L
8. NAME four forms of energy:	 heat light electricity sound (any order)

1. Can the items listed below be classified as matter or energy? Are there some items listed that cannot be classified as either matter or energy?

	Matter	Energy	Neither Matter nor Energy
A. a container			
B. an inch			
C. invisible ink			
D. the sound of music			
E. sunlight			
F. your thoughts			

2. Light, sound, and electricity:

   a. ☐ are forms of matter

   b. ☐ can be converted into heat

   c. ☐ have volume

3. When <u>all</u> the properties of a substance change, the substance has gone through a:

   a. ☐ chemical change

   b. ☐ physical change

9. LABEL the items below either M for matter or E for energy: _____ an electric stove _____ the heat from an electric stove _____ a light bulb _____ the light from a light bulb _____ light reflected from a mirror _____ a mirror	 M E M E E M
10. Heat is the form of energy that is involved in most of our daily activities. First of all, it is the form of energy that our bodies use to carry on life's activities. The energy that comes from burning coal, oil, and gasoline is released in the form of heat. Many electrical processes also involve heat. For this reason measuring the quantity of heat is one of the easiest and most important ways of measuring energy. NO RESPONSE REQUIRED	 GO ON TO THE NEXT FRAME

MASTERY TEST

Time started _____

11.

Recall for a moment that you learned about units in the metric and English systems that are used for length, area, volume and weight.

A quantity of heat is also measured in both the English and metric systems.

A British thermal unit (B.T.U.) is defined as the quantity of heat required to raise the temperature of one pound of water from 59° to 60° F.

A calorie is defined as the quantity of heat required to raise the temperature of one gram of water from 15° to 16° C.

MATCH the terms below with the system in which they are used to measure a quantity of heat:

A. calorie
B. B.T.U.

1. _____ Centigrade
2. _____ English
3. _____ Fahrenheit
4. _____ Metric

1. A
2. B
3. B
4. A

12.

Calories and B.T.U.'s are used to measure:

☐ the amount of heat required to change the temperature of a substance

☐ the temperature of a substance

the amount of heat required. . .

Which is a part of the metric system of measurement?

☐ B.T.U.'s
☐ calories

calories

OPINION	what someone thinks or believes EXAMPLE: New York is a nice city
FACT	something that is true beyond a doubt EXAMPLE: New York is the largest city in the United States
SCIENTIFIC LAW	a scientific fact
SCIENTIFIC THEORY	a scientific opinion

13. The quantity of heat is related to the number and the motion of the molecules of a substance. The more molecules a substance has and the greater the motion of its molecules, the more heat the substance will have. Temperature is only a measure of the degree of hotness. Two substances may have the same degree of hotness but contain different quantities of heat. This is not as difficult to understand as you may think. GO ON TO THE NEXT FRAME and you will see that you are already familiar with examples of this fact. NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME
14. When you come into a very cold room and light a fire or turn up the heat, you raise the temperature of the air in the room more quickly than you raise the temperature of some objects in the room. In other words, the air will warm up after a few minutes, but metal objects (like a fork or a metal venetian blind) will take longer to reach the same temperature. It would require more heat to raise the temperature of: ☐ a piece of steel 1 foot square ☐ one cubic foot of air	a piece of steel 1 foot square
15. If the temperature of a piece of steel and a gas that occupies the same amount of space is 78°F., the: ☐ gas and the steel will contain equal quantities of heat ☐ gas will contain a greater quantity of heat ☐ steel will contain a greater quantity of heat	steel will contain a greater ...

ENERGY	that which has the ability to move matter EXAMPLE: heat increases the movement of molecules; therefore, heat is a form of energy sound, light, and electricity are also forms of energy
MEASURING ENERGY	when we measure the quantity of heat, sound, light or electricity, we are measuring energy
QUANTITY OF HEAT	quantity of heat is related to the number and the motion of the molecules of a substance; the more molecules a substance has and the greater the motion of its molecules, the more heat the substance will have EXAMPLE: if the temperature of a piece of steel and of a gas that occupies the same amount of space is 78°F, the steel will contain a greater quantity of heat
BRITISH THERMAL UNIT (B. T. U.)	the quantity of heat needed to raise the temperature of one pound of water 1°F
CALORIE	the quantity of heat needed to raise the temperature of one gram of water 1°C calories and B.T.U.'s are used to measure the amount of heat required to change the temperature of a substance
CHEMICAL CHANGE IN THE PROPERTIES OF MATTER	a change that produces a new substance with totally new properties EXAMPLE: burning paper into ashes
PHYSICAL CHANGE IN THE PROPERTIES OF MATTER	a change that alters some properties of a substance but does not produce a new substance EXAMPLE: freezing water into ice; the state has changed, but the substance remains the same

16.

MATCH the columns below:

A. a B. T. U.	1._____measures a quantity of heat in the metric system.	1. D.
B. the Centigrade thermometer	2._____measures the degree of hotness in the metric system.	2. B.
C. the Fahrenheit thermometer	3._____measures the degree of hotness in the English system.	3. C.
D. a calorie	4._____measures a quantity of heat in the English system.	4. A.

17.

REVIEW FRAME

Shape, color, taste, hardness, and odor are:

☐ states of matter
☐ properties of matter

properties of matter

When water turns to ice:

☐ it becomes a new substance
☐ it is the same substance

it is the same substance

When ice turns to water, it loses its shape. Are all the properties of water in the solid state the same as the properties of water in the liquid state?

☐ yes ☐ no

no

18.

If we cut a piece of wood into two parts, do we change all of the properties of the wood?

☐ yes ☐ no

no

Each piece of the wood is:

☐ the same substance
☐ a different substance

the same substance

32.

Can a chemical change such as burning produce a form of energy?

☐ yes
☐ no

yes

33.

When we burn matter, the matter is not actually converted to energy, since none of the matter is lost. In a later lesson, you will see how matter can actually be converted to energy.

(M ⟶ E)

We will also describe the change of energy into matter.

(E ⟶ M)

The fact that matter and energy can be interconverted is a scientific law. It is one of the most interesting and important discoveries that man has made. You will learn more about this change in later lessons.

Time completed _____

YOU HAVE NOW FINISHED THE FIRST PART OF THIS LESSON. WRITE DOWN THE TIME. THEN, AFTER YOU HAVE REVIEWED THE MAIN IDEAS IN THE FOLLOWING SUMMARY, TAKE THE MASTERY TEST AT THE END OF THE BOOKLET.

19. If we freeze or melt a substance, or cut it up into small pieces, or grind it or chip it, we do not change the substance. We may change one or more of its properties, but we do not change all of its properties. When we mash a potato, do we change the substance? ☐ yes ☐ no When we grind nuts, do we change the substance? ☐ yes ☐ no	 no no
20. The properties that can be used to describe a cigarette before and after it has been lit are listed below. CHECK the properties that are changed as a result of burning the cigarette: ☐ color ☐ odor ☐ taste ☐ shape ☐ solubility	 color odor taste shape solubility

29. A scientific law is: ☐ always true ☐ sometimes true A scientific theory is: ☐ always true ☐ sometimes true	always true sometimes true
30. In previous frames, we talked about changes that could involve the forms of energy. We will now see that the forms of energy are also involved in changes that take place in matter. NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME
31. CHECK the things that happen when we burn wood: ☐ A new substance is formed. ☐ Light is given off from the burning wood. ☐ The properties of wood are completely changed. ☐ Heat is given off from the burning wood.	A new substance . . . . Light is given . . . . The properties of wood . . . . Heat is given off . . . .

21. Burning changes all of the properties of a substance. When all of the properties of a substance have been changed, the substance has been changed. When we bu.. wood, do all or some of its properties change? ☐ all ☐ some When we burn wood, do we change the substance? ☐ no ☐ yes When we burn paper, do all or some of its properties change? ☐ all ☐ some When we burn paper, do we change the substance? ☐ no ☐ yes	all yes all yes
22. Coal and the ash left after burning coal are: ☐ different substances ☐ the same substance Coal has properties that are: ☐ the same as the properties of ash except that the shape of the coal has been changed ☐ totally different from the properties of ash	different substances totally different . . .

27. When someone says what they think is true, they are giving us their <u>opinion</u>. When someone tells us something that is true beyond any doubt, they are stating a <u>fact</u>. LABEL the statements below that are opinions with an <u>O</u>. LABEL the statements that are facts with an <u>F</u>. 1. _____ The world is round. 2. _____ It will rain 3 days from today. 3. _____ There are people on Mars. 4. _____ There will be a third world war in one year. 5. _____ Night and day occur because the earth turns on its axis.	 F O O O F
28. The words fact and opinion also have a place in scientific language. A scientific fact is a <u>law</u>. A law is always <u>true</u>. For example, when we burn wood, a new substance is always produced. A scientific opinion is a <u>theory</u>. A theory explains what seems to be true. <u>Sometimes</u> a theory is proven to be false after more experiments are made; sometimes it is proven to be true. An example of a theory is: atomic bomb testing disturbs the seasons. LABEL the statement(s) below that represent(s) a law with an <u>L</u> and those that represent a theory with a <u>T</u>. 1. _____ The molecules of a solid are more closely packed together than the molecules of a gas. 2. _____ There are forms of life on other planets that are similar to the forms of life found on earth. 3. _____ One form of energy can be converted to another form of energy.	 L T L

23.

When a change occurs that produces a new substance with totally new properties, we say that a chemical change has taken place.

When a change occurs that alters some of the properties of a substance but does not produce a new substance, we say that a physical change has taken place.

When we burn wood, a:

☐ chemical change occurs
☐ physical change occurs

chemical change occurs

When we freeze water, a:

☐ chemical change occurs
☐ physical change occurs

physical change occurs

24.

Burning always produces a chemical change.

A change from one state of matter to another state of matter is always a physical change.

LABEL the items below with CC if they represent chemical changes, and with a PC if they represent a physical change:

1. _____ water boiling — PC
2. _____ ice cream melting — PC
3. _____ cigarette burning — CC
4. _____ gasoline burning in a moving car — CC

25.

MATCH the correct characteristics of each change:

A. A chemical change

B. A physical change

1._____ changes all of the properties of a substance

2._____ changes some of the properties of a substance

3._____ produces a new substance

4._____ does not produce a new substance

1. A

2. B

3. A

4. B

26.

PREVIEW FRAME

When scientists use words to talk about the changes that take place in the world, they try to be as exact as possible.

In talking to your friend you do not always use exact words. Sometimes you use the word millions to make a point when you only mean hundreds or just a lot of something.

Sometimes, you say what you think is true without actually knowing whether it is true or not. In the next few frames, you will learn what words scientists use to say that something is true or that something may be true.

NO RESPONSE REQUIRED

GO ON TO THE NEXT FRAME

PM 431 - 21

ED 069986

ADVANCED GENERAL EDUCATION PROGRAM

A HIGH SCHOOL SELF-STUDY PROGRAM

THE PARTICLES AND STRUCTURE OF MATTER

LEVEL: I

UNIT: 6

LESSON: 5

U.S. DEPARTMENT OF LABOR
MANPOWER ADMINISTRATION, JOB CORPS
NOVEMBER 1969

141

U.S. DEPARTMENT OF LABOR
MANPOWER ADMINISTRATION, JOB CORPS
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1. PREVIEW FRAME In the first lesson, you learned that the smallest possible amount of a substance is called a molecule. In this lesson you will learn that molecules are composed of even tinier particles and that all substances are basically composed of the same kinds of tiny particles. NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME
2. The molecules of all the different kinds of matter in the world are made up of extremely tiny particles. Tiny particles make up: ☐ a molecule of the paper you are writing on ☐ a molecule of your hand ☐ your thoughts	a molecule of the paper . . . a molecule of your hand

7. A compound is a result of a:

a. ☐ chemical change
b. ☐ physical change

Time completed _____

WHEN YOU HAVE FINISHED THIS TEST, WRITE DOWN THE TIME. THEN TAKE THE LESSON TO YOUR INSTRUCTOR OR HIS ASSISTANT FOR CHECKING. WAIT UNTIL THE LESSON IS APPROVED BEFORE GOING ON TO THE NEXT LESSON.

* U. S. GOVERNMENT PRINTING OFFICE : 1970 O - 389-828

3.

In the first lesson, we represented a molecule by a small circle.

The particles that make up a molecule can also be represented by small circles. If we could see a molecule and the tiny particles that a molecule is composed of, we would see that the molecule is much larger than the tiny particles from which it is made.

The circles below represent tiny particles.

If you had to draw a circle representing a molecule next to them, you would draw a circle:

- ☐ much larger than the ones above
- ☐ much smaller than the ones above
- ☐ the same size as the ones above

much larger than the ones above

PANEL 1

Drawing No. 1

Drawing No. 2

Drawing No. 3

4.

LOOK AT PANEL 1 (Page 3)

Drawing No. 1 on Panel 1 shows two particles next to one another. The arrows show the effect that the two particles have on one another. The arrows show that the particles:

- ☐ attract one another
- ☐ repel one another
- ☐ neither attract nor repel one another

attract one another

Drawing No. 2 shows two more particles. These particles:

- ☐ attract one another
- ☐ repel one another
- ☐ neither attract nor repel one another

repel one another

The particles in Drawing No. 3:

- ☐ attract one another
- ☐ repel one another
- ☐ neither attract nor repel one another

neither attract nor repel one another

1. If one particle has a positive charge and another particle has a negative charge, they will:

   a. ☐ attract one another
   b. ☐ repel one another.
   c. ☐ neither attract nor repel one another.

2. MATCH the items below with the charge that they carry:

A. no charge	1. _____ the atom as a whole
B. negative charge	2. _____ an electron
C. positive charge	3. _____ a neutron
	4. _____ a proton

3. An atom always has the same number of what two particles?

   a. ☐ electrons
   b. ☐ neutrons
   c. ☐ protons

4. The atomic mass of an atom is equal to the number of its:

   a. ☐ electrons and protons
   b. ☐ protons
   c. ☐ protons and neutrons

5. The atomic number of an atom is equal to the number of its:

   a. ☐ electrons and protons
   b. ☐ protons
   c. ☐ protons and neutrons

6. The smallest part of an <u>element</u> is:

   a. ☐ an atom
   b. ☐ a molecule

Skip one(1) page for question 7.

5. REFER TO PANEL 1 By looking at the particles on the panel, you can see that attraction or repulsion occurs between: ☐ all particles ☐ some particles	some particles
6. Particles that attract or repel one another have <u>electric charges</u>. REFER TO PANEL 1 CHECK the particles represented in Panel 1 that have electric charges: ☐ those in Drawing No. 1 ☐ those in Drawing No. 2 ☐ those in Drawing No. 3	. . . No. 1 . . . No. 2
7. Particles with electric charges: ☐ attract one another ☐ repel one another ☐ neither attract nor repel one another	attract one another repel one another

MASTERY TEST

Time started _____

8.

There are two types of electric charges: a positive charge and a negative charge. A positive charge is represented by a plus sign "+" and a negative charge is represented by a minus sign "-".

A particle with the sign "+" would be a particle with:

- ☐ a negative charge
- ☐ a positive charge
- ☐ no charge

a positive charge

A particle with the sign "-" would be a particle with:

- ☐ a negative charge
- ☐ a positive charge
- ☐ no charge

a negative charge

A particle with neither the sign "+" nor the sign "-" would be a particle with:

- ☐ a negative charge
- ☐ a positive charge
- ☐ no charge

no charge

6

ATOMIC PARTICLES	two particles with the same charge repel one another EXAMPLE: two electrons repel one another two particles with opposite charges attract one another EXAMPLE: a proton and an electron attract one another a particle with no charge and a particle with a positive or a negative charge neither attract nor repel one another EXAMPLE: a neutron and a proton (or an electron) neither attract nor repel one another
ELEMENT	each <u>different</u> <u>type</u> of atom; there are 103 different types of atoms known to man; therefore, there are 103 elements; each element has a name and a symbol EXAMPLES: Calcium (Ca) Bromine (Br) Antimony (Sb), etc.
COMPOUND	a substance produced by the combination of 2 or more elements that have reacted chemically with one another EXAMPLE: carbon + oxygen = carbon dioxide
COMPARING ATOMS AND MOLECULES	an atom is the smallest part of an <u>element</u> in the uncombined state a molecule is the smallest part of a <u>compound</u>

152

9.

WRITE the number of the type of charge by the sign that stands for it:

1. negative charge _____ +
2. no charge _____ -
3. positive charge

3. +

1. -

ELECTRIC CHARGES	that property of particles that causes them to attract or repel one another there are two types of electric charges: a positive (+) charge and a negative (-) charge
ATOM	atoms are made up of protons, neutrons, and electrons the number of protons and electrons in an atom is always equal; the atom as a whole has no electric charge
PROTON	a particle with a positive charge
ELECTRON	a particle with a negative charge
NEUTRON	a particle with no charge
NUCLEUS	center of the atom; made up of protons and neutrons; has a positive charge
ELECTRON ORBIT	circular path that the electrons follow around the nucleus; the negatively charged electrons in orbit are attracted to the positively charged nucleus the more energy an electron has, the farther away its orbit will be from the nucleus an atom may have anywhere from 1 to 7 electron orbits; the 7 orbits are designated by their letters: the first orbit (innermost) is designated by K; the second orbit, L; the third, M; the fourth, N; the fifth, O; the sixth, P; and the seventh, Q
ATOMIC RADIUS	the distance from the center of the nucleus to the outermost orbit of the atom
ATOMIC NUMBER	number of protons in an atom
ATOMIC MASS NUMBER	total number of protons and neutrons in an atom

10.

The drawing above represents the particles that make up matter. The signs inside the circles show the electric charge of the particles.

The drawing shows that there are particles with:

- ☐ negative charges
- ☐ positive charges
- ☐ no charge

How many different types of particles are there? _____

negative charges

positive charges

no charge

3

77.

REFER TO PANEL 4 IF NECESSARY

All substances are composed of tiny particles called electrons, protons, and neutrons.

CHECK each of the following that is composed of these particles:

- ☐ a compound
- ☐ an atom
- ☐ an element
- ☐ a substance
- ☐ carbon dioxide
- ☐ copper
- ☐ happiness
- ☐ light
- ☐ magnesium sulfide
- ☐ nickel
- ☐ sound
- ☐ sulfur

a compound
an atom
an element
a substance
carbon dioxide
copper

magnesium sulfide
nickel

sulfur

78.

Of the 103 elements, only 6 never combine to form compounds.

Sometimes a compound is a combination of only 2 different elements; sometimes it is a combination of many different elements.

From this information, you can say that there are:

- ☐ many different substances in the world
- ☐ not many different substances in the world

many different . . .

79.

In later lessons you will learn <u>how</u> elements combine to form compounds and <u>why</u> elements form the combinations that they do.

Time completed _____

YOU HAVE NOW FINISHED THE FIRST PART OF THIS LESSON. WRITE DOWN THE TIME. THEN, AFTER YOU HAVE REVIEWED THE MAIN IDEAS IN THE FOLLOWING SUMMARY, TAKE THE MASTERY TEST AT THE END OF THE BOOKLET.

11.

A particle with a positive charge is called a proton; a particle with a negative charge is called an electron; and a particle with no charge is called a neutron.

MATCH the drawings on the right below with the names on the left:

A. electron ⊖ _____

B. neutron ○ _____

C. proton ⊕ _____

B

A

C

12.

You know that there are three types of particles within an atom, and that each has a different type of charge.

USE this information to FILL IN the missing letters in the sentences below:

An _l_ctron is a particle with a n_gativ_ charge.

A _eutron is a particle with _o charge.

A _roton is a particle with a _ositive charge.

electron, negative

neutron, no

proton, positive

13.

WRITE the symbols below by the particle they represent:

○ _____ electron

⊖ _____ neutron

⊕ _____ proton

⊖

○

⊕

75.

REFER TO PANEL 4

The smallest part of an element is an atom. Put an A in front of the smallest part of a substance that could be an atom.

The smallest part of a compound is a molecule. Put an M in front of the smallest part of a substance that could be a molecule.

_____	brass	M
_____	copper	A
_____	oil	M
_____	soda	M
_____	sulfur	A
_____	zinc	A

76.

MATCH the columns below:

A.	atom	1. _____	a compound	1. C
B.	molecule	2. _____	an element	2. C
C.	substance	3. _____	the smallest possible part of an element in the uncombined state	3. A (and C)
		4. _____	the smallest possible part of elements in the combined state	4. B (and C)

14.

FILL IN the blanks:

_l_ctron	n_gativ_ charge
_eutron	_o charge
_roton	_ositive charge

electron	negative charge
neutron	no charge
proton	positive charge

15.

CHECK the appropriate boxes below:

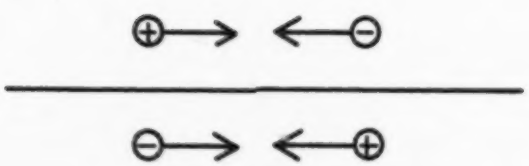
	positive charge	negative charge	no charge
electron	☐	☐	☐
neutron	☐	☐	☐
proton	☐	☐	☐

	pos. ch.	neg. ch.	no ch.
electron	☐	☒	☐
neutron	☐	☐	☒
proton	☒	☐	☐

PANEL 2

Drawing No. 1

Drawing No. 2



Drawing No. 3

16.

LOOK AT PANEL 2

Drawing No. 1 shows that two particles with the same charge:

- ☐ attract one another
- ☐ neither attract nor repel one another
- ☐ repel one another

repel one another

Drawing No. 2 shows that two particles with opposite charges:

- ☐ attract one another
- ☐ neither attract nor repel one another
- ☐ repel one another

attract one another

Drawing No. 3 shows that a particle with no charge and a particle with a positive or a negative charge:

- ☐ attract one another
- ☐ neither attract nor repel one another

neither attract nor repel one . . .

74.

REFER TO PANEL 4

When we talk about the smallest possible part of an element in the uncombined state, we use the word atom.

When we talk about the smallest possible part of a compound (chemically combined elements), we use the word molecule.

Can you have an atom of gold?

- ☐ no
- ☐ yes

yes

Can you have an atom of carbon dioxide?

- ☐ no
- ☐ yes

no

Can you have a molecule of iron?

- ☐ no
- ☐ yes

no

Can you have a molecule of iron oxide?

- ☐ no
- ☐ yes

yes

Gold, carbon dioxide, iron, and iron oxide are:

- ☐ all substances
- ☐ not substances

all substances

17.

REFER TO PANEL 2

Attraction occurs between:

- ☐ a particle with no charge and a particle with a positive or a negative charge
- ☐ two particles with opposite charges
- ☐ two particles with the same charge

two particles with opposite . . .

Which two particles attract one another?

- ☐ electron
- ☐ neutron
- ☐ proton

electron

proton

72.

REFER TO PANEL 4

A substance produced by the combination of two or more elements that have reacted chemically with one another is called a compound.

LABEL the substances that are elements E and those that are compounds C:

_____	bread	C
_____	gold	E
_____	hydrogen	E
_____	oxygen	E
_____	water	C
_____	wood	C

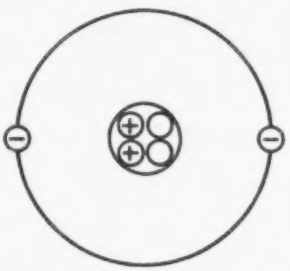
73.

When we use the word substance, we are referring to:

- ☐ elements and compounds
- ☐ only compounds
- ☐ only elements

elements and compounds

18.



The particles that make up matter are arranged in a special way. The drawing above shows the arrangement.

The drawing shows that in the center there are:

- ☐ particles with a negative charge
- ☐ particles with a positive charge
- ☐ particles with no charge

And traveling around the center there are:

- ☐ particles with a negative charge
- ☐ particles with a positive charge
- ☐ particles with no charge

particles with a positive charge

particles with no charge

particles with a negative charge

70.

If the elements silver and gold are mixed together in a pan, nothing happens. After a few minutes, the gold and the silver can be removed and separated.

If, however, the silver is mixed with the element chlorine, the elements combine and a completely new substance is produced (called silver chloride).

When a change occurs that produces a new substance we say that:

- ☐ a chemical change has occurred
- ☐ a physical change has occurred
- ☐ no real change has occurred

Silver chloride is an example of a:

- ☐ chemical change that has occurred
- ☐ physical change that has occurred
- ☐ none of the above

a chemical change . . .

chemical change . . .

71.

When two elements combine to form a new substance, we say that they have gone through a chemical change or that they have <u>reacted chemically</u>.

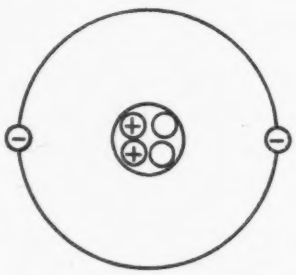
In the list of substances below, CHECK the items which are examples of elements that have reacted chemically:

- ☐ carbon
- ☐ carbon dioxide
- ☐ iron oxide
- ☐ sodium
- ☐ sodium chloride

carbon dioxide
iron oxide

sodium chloride

19.



The electrons, protons, and neutrons that make up matter are not mixed together in a random fashion. They are arranged in the special way shown above.

The drawing shows that in the center of the arrangement there are:

- ☐ electrons
- ☐ neutrons
- ☐ protons

Traveling in a circular path around the center there are:

- ☐ electrons
- ☐ neutrons
- ☐ protons

neutrons

protons

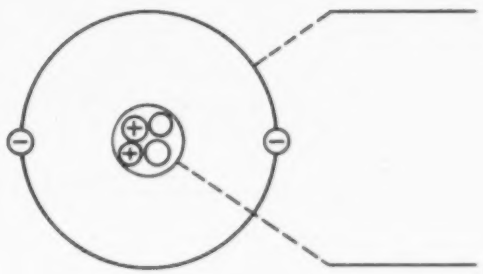
electrons

67. REVIEW FRAME We have two <u>substances</u> if we have: ☐ two different kinds of matter ☐ two forms of energy ☐ two objects that are the same kind of matter A molecule is a word used to refer to: ☐ a particle such as a proton ☐ anything that is too small to be seen ☐ the smallest possible amount of a substance	two different kinds of matter the smallest possible ...
68. Each of the 103 elements is a different kind of matter. So if you had 10 atoms of each of the 103 elements, you would have: ☐ 10 x 103 elements (1,030 elements) ☐ 10 substances ☐ 103 substances ☐ 10 x 103 substances (1,030 substances)	103 substances
69. You are probably wondering why there are so many different kinds of matter in the world if there are only 103 elements. This will be explained in the next few frames. NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME

20.

An arrangement such as that shown in the last frame is called an atom. The center of the atom is called the nucleus, and the circular path that the electrons follow around the nucleus is called an orbit.

LABEL the drawing below:



orbit

nucleus

This drawing represents a(n) _____. atom

NOTE NOTE NOTE NOTE NOTE

Skip one(1) page to find page 17 and 18.

65.

LOOK AT PANEL 4

In addition to a name, each element has a symbol made up of 1 or 2 letters which are usually, but not always, taken from the name of the element. For example, the symbol for the element named calcium is Ca.

What is the symbol for the element named antimony?
_____ Sb

Are the letters in this symbol taken from the name of the element?

☐ yes

☐ no no

What is the symbol for bromine?_____ Br

Are the letters for this symbol taken from the name of the element?

☐ yes yes

☐ no

66.

Each element has a:

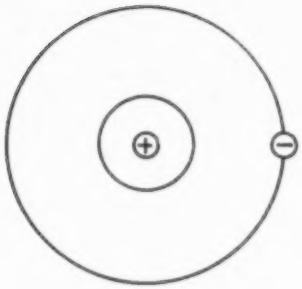
☐ name name

☐ symbol symbol

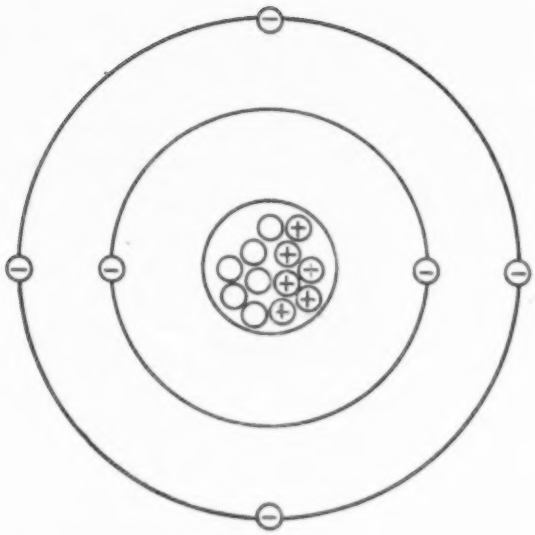
PANEL 4

ELEMENT	SYMBOL	AT. NO.	ELEMENT	SYMBOL	AT. NO.
Actinium	Ac	89	Mercury	Hg	80
Aluminum	Al	13	Molybdenum	Mo	42
Americium	Am	95	Neodymium	Nd	60
Antimony	Sb	51	Neon	Ne	10
Argon	A	18	Neptunium	Np	93
Arsenic	As	33	Nickel	Ni	28
Astatine	At	85	Niobium	Nb	41
Barium	Ba	56	Nitrogen	N	7
Berkelium	Bk	97	Nobelium	No	102
Beryllium	Be	4	Osmium	Os	76
Bismuth	Bi	83	Oxygen	O	8
Boron	B	5	Palladium	Pd	46
Bromine	Br	35	Phosphorus	P	15
Cadmium	Cd	48	Platinum	Pt	78
Calcium	Ca	20	Plutonium	Pu	94
Californium	Cf	98	Polonium	Po	84
Carbon	C	6	Potassium	K	19
Cerium	Ce	58	Praseodymium	Pr	59
Cesium	Cs	55	Promethium	Pm	61
Chlorine	Cl	17	Protactinium	Pa	91
Chromium	Cr	24	Radium	Ra	88
Cobalt	Co	27	Radon	Rn	86
Copper	Cu	29	Rhenium	Re	75
Curium	Cm	96	Rhodium	Rh	45
Dysprosium	Dy	66	Rubidium	Rb	37
Einsteinium	Es	99	Ruthenium	Ru	44
Erbium	Er	68	Samarium	Sm	62
Europium	Eu	63	Scandium	Sc	21
Fermium	Fm	100	Selenium	Se	34
Fluorine	F	9	Silicon	Si	14
Francium	Fr	87	Silver	Ag	47
Gadolinium	Gd	64	Sodium	Na	11
Gallium	Ga	31	Strontium	Sr	38
Germanium	Ge	32	Sulfur	S	16
Gold	Au	79	Tantalum	Ta	73
Hafnium	Hf	72	Technetium	Tc	43
Helium	He	2	Tellurium	Te	52
Holmium	Ho	67	Terbium	Tb	65
Hydrogen	H	1	Thallium	Tl	81
Indium	In	49	Thorium	Th	90
Iodine	I	53	Thulium	Tm	69
Iridium	Ir	77	Tin	Sn	50
Iron	Fe	26	Titanium	Ti	22
Krypton	Kr	36	Tungsten	W	74
Lanthanum	La	57	Uranium	U	92
Lawrencium	Lw	103	Vanadium	V	23
Lead	Pb	82	Xenon	Xe	54
Lithium	Li	3	Ytterbium	Yb	70
Lutetium	Lu	71	Yttrium	Y	39
Magnesium	Mg	12	Zinc	Zn	30
Manganese	Mn	25	Zirconium	Zr	40
Mendelevium	Md	101			

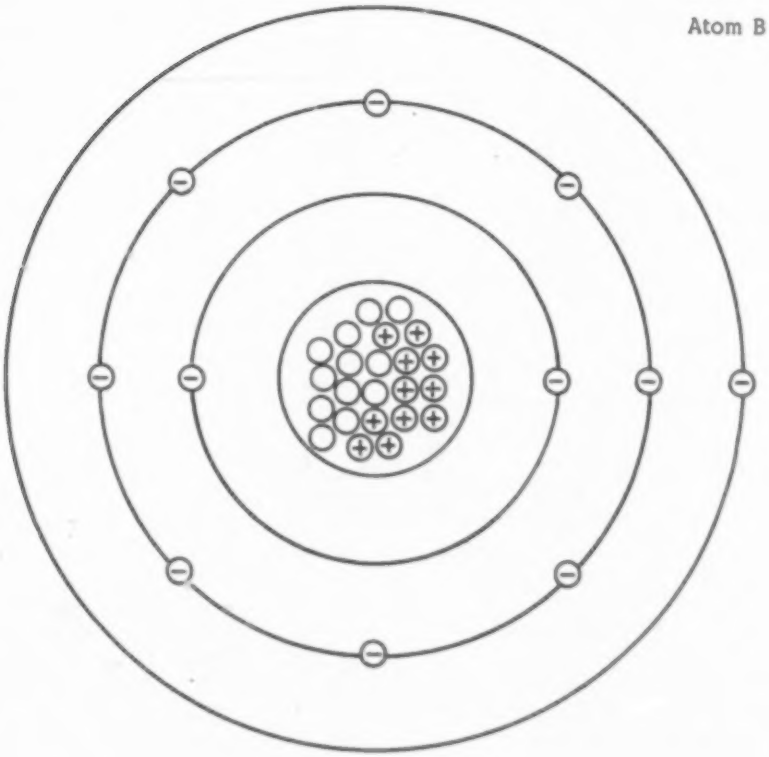
PANEL 3



Atom A



Atom B



Atom C

21.

LOOK AT PANEL 3 (Page 17).

PANEL 3 shows three atoms. These atoms each have:

- ☐ a different numbers of protons, electrons, and neutrons
- ☐ the same number of protons, electrons, and neutrons

a different number...

22.

REFER TO PANEL 3

By inspecting the drawings, FILL IN the following table:

	Atom A	Atom B	Atom C
number of electrons in orbit	____	____	____
number of neutrons in nucleus	____	____	____
number of nuclei*	____	____	____
number of orbits	____	____	____
number of protons in nucleus	____	____	____

Atom A	Atom B	Atom C
1	6	11
0	6	12
1	1	1
1	2	3
1	6	11

*The plural form of nucleus is nuclei.

63.

MATCH the phrases below so that both statements will be true:

A. All the atoms of an element	1. _____ have different atomic numbers	1. B
B. The atoms of different elements	2. _____ have the same atomic numbers	2. A

64.

LOOK AT PANEL 4 (Page 45).

Each of the 103 elements has a name. Gold, silver, and aluminum are the names of some elements with which you are probably already familiar. The names of all 103 elements are listed alphabetically in PANEL 4.

Is actinium an element?

- ☐ yes
- ☐ no

yes

Is barium an element?

- ☐ yes
- ☐ no

yes

23.

REFER TO PANEL 3

The nucleus of an atom can have:

- ☐ one or more electrons
- ☐ one or more protons
- ☐ one neutron and no protons
- ☐ one proton and no neutrons

one or more protons

one proton and no neutrons

Around the nucleus there can be:

- ☐ one or more electrons
- ☐ one or more neutrons
- ☐ one or more protons

one or more electrons

An atom can have:

- ☐ one or more orbits
- ☐ one or more nuclei

one or more orbits

61.

COMPARE the atomic mass and the atomic number of an atom:

	mass number	atomic number	mass number	atomic number
Which number(s) is/are based on neutrons?	☐	☐	☒	☐
Which number(s) is/are based on protons?	☐	☐	☒	☒
Which number is the same for all atoms of a given type?	☐	☐	☐	☒
Which number varies even for types of atoms?	☐	☐	☒	☐

62.

Since there are only 103 different types of atoms in the world that are known to man, and since atoms are so small, you can guess that there must be billions upon billions of each type of atom in the world.

Each different type of atom is called an element.

How many elements are known to man? _____

103

24. REFER TO PANEL 3.

	Atom A	Atom B	Atom C
number of electrons in orbit	1	6	11
number of neutrons in nucleus	0	6	12
number of protons in nucleus	1	6	11

The table above gives the number of protons, neutrons, and electrons in each of three different atoms.

INSPECT the number of protons and the number of electrons in each atom. It appears that the number of protons and the number of electrons is:

- ☐ always equal
- ☐ not always equal

always equal

INSPECT the number of protons and the number of neutrons in each atom. It appears that the number of protons and the number of neutrons is:

- ☐ always equal
- ☐ not always equal

not always equal

Which particle is not present in Atom A?

- ☐ electron
- ☐ neutron
- ☐ proton

neutron

59.

The atomic number of an atom is based on the number of its:

- ☐ electrons
- ☐ neutrons
- ☐ protons

If two atoms have a different number of protons:

- ☐ they are different types of atoms
- ☐ they are the same types of atoms but have different masses

protons

they are different types of atoms

60.

WRITE the atomic mass and the atomic number of each atom below:

Atom	Electrons	Neutrons	Protons	Atomic Mass	Atomic No.
A	4	4	4	____	____
B	13	13	13	____	____
C	20	22	20	____	____

8	4
26	13
42	20

25. Which particles are always present in equal numbers in an atom? ☐ electrons ☐ neutrons ☐ protons	electrons protons
26. In our diagrams, the orbits are represented as concentric circles around the nucleus. Actually, orbits are only the paths that the electrons follow as they move at very high speeds around the nucleus. Thus, the number of orbits an atom will have is related to the number of its electrons. Which atom below has the greatest number of orbits? ☐ Atom A with 55 electrons ☐ Atom B with 2 electrons ☐ Atom C with 103 electrons	Atom C with 103 electrons

58.

For convenience, each type of atom is assigned a number by which it can be easily identified. This number is based on the number of protons the atom contains. It is called the atomic number.

The atomic number of an atom with 72 protons is _____. 72

An atom with an atomic number of 11 has _____ protons. 11

Can you say what the atomic number of an atom with 17 electrons is?

- ☐ yes
- ☐ no

no

Can you say how many neutrons an atom with an atomic number of 100 has?

- ☐ yes
- ☐ no

no

The atomic number of an atom is based on the number of its:

- ☐ electrons
- ☐ neutrons
- ☐ protons

protons

The atomic mass of an atom is based on the number of its:

- ☐ electrons
- ☐ neutrons

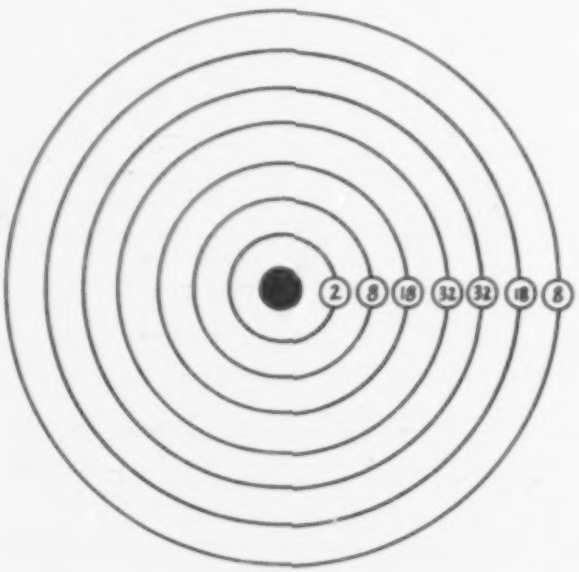
neutrons

- ☐ protons

protons

27.

The diagram below shows the maximum number of orbits an atom can have and the greatest number of electrons that can be found in any one orbit.



LOOK AT the diagram again. What is the maximum number of orbits an atom can have? _____

7

*It is too cumbersome to show every neutron, proton, and electron in an atom. Frequently the number of particles is simply indicated in the nucleus and in each orbit.

56.

If an atom gains or loses one or more of its electrons, the uneven number of positive and negative charges causes the atom as a whole to have either a positive or a negative charge. However, an atom does not become a different type of atom unless the number of its protons is changed.

Which particle would you guess can be used to identify which type an atom is?

- ☐ electron
- ☐ neutron
- ☐ proton

proton

57.

An atom can contain from 1 to 103 [illegible]ons.

How many different types of atoms would you expect there to be? _____

103

The atomic mass of each atom is based on its:

- ☐ electrons
- ☐ neutrons
- ☐ protons

neutrons
protons

28.

The letters K L M N O P Q are used to designate the orbits of an atom. They are always used in the same order; thus, the innermost orbit is always K; the second orbit, L; etc.

After the letter K, each orbit of an atom is given:

- ☐ any letter of the alphabet
- ☐ the next letter of the alphabet

the next letter ...

55.

REVIEW FRAME

In order for the atom as a whole to have no charge, which particles must be present in equal numbers?

- ☐ electrons
- ☐ neutrons
- ☐ protons

electrons

protons

29.

WRITE IN the remaining letters for the orbits of the atoms shown below:

O P Q

The innermost orbit of any atom is the _____.

K orbit

53.

The actual masses of atoms are such small numbers that it was decided to adopt an easier way to show the difference between the masses of different atoms. Since the protons and the neutrons of an atom contribute most to its mass, the mass of an atom can be more simply indicated as the combined number of its protons and neutrons. This is known as the atomic mass number.

WRITE the atomic mass of each of the following atoms:

	number of protons	number of neutrons	atomic mass
Atom A	2	2	____
Atom B	16	15	____
Atom C	10	11	____

4

31

21

54.

The atomic mass of an atom is based on the number of its:

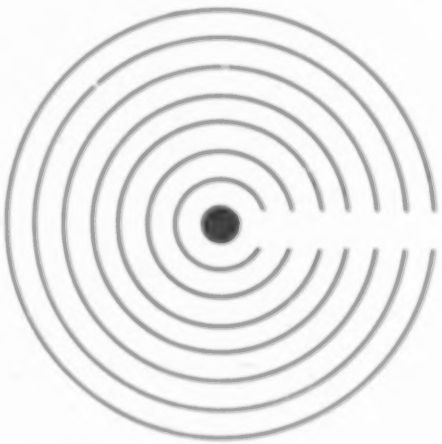
- ☐ electrons
- ☐ neutrons
- ☐ protons

neutrons

protons

30.

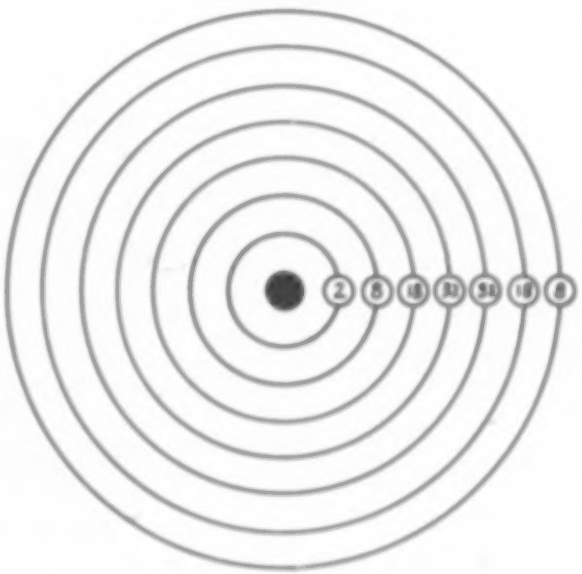
WRITE IN the letters used to designate the orbits of the atom shown below:



K L M N O P Q

51. If electrons were closer to the nucleus, the size of an atom would not be so great. Thus, what determines the size of an atom is primarily: ☐ the electrons in their orbits ☐ the protons and neutrons in the nucleus	 the electrons in their orbits
52. Which particles contribute most to the mass of an atom? ☐ electrons ☐ neutrons ☐ protons Which particles contribute most to the atomic radius of an atom? ☐ electrons ☐ neutrons ☐ protons	 neutrons protons electrons

31.



There is not an indefinite number of electrons in the orbit of an atom. For example, the K orbit never has more than 2 electrons. The maximum capacities of all the orbits are shown in the drawing above.

What is the greatest number of electrons that can be in the outermost orbit? _____

8

49. An electron contributes less than the proton or neutron to the mass of an atom, but it occupies more space than the proton or neutron. However, even the space occupied by an electron is dwarfed by the great space that is between it and the nucleus of the atom or an electron in the next orbit. Which is greatest? ☐ the space between the first and second orbit of an atom ☐ the space occupied by an electron ☐ the space occupied by a proton	the space between the first ...
50. The protons and neutrons are packed together very closely in the nucleus. This tightly packed core is surrounded by the electrons moving in their orbits. The space occupied by all the particles is very small compared to the space between the nucleus and the first orbit and between the first and second orbit, etc. Thus, an atom: ☐ consists mostly of tightly packed protons, neutrons, and electrons ☐ is mostly empty space	is mostly empty space

32.

The number of electrons that are in any one orbit of an atom:

- ☐ is not known
- ☐ never exceeds the maximum capacity of that orbit

never exceeds the . . .

33.

REVIEW FRAME

CHECK the appropriate boxes below:

	positive charge	negative charge	no charge
electron	☐	☐	☐
neutron	☐	☐	☐
proton	☐	☐	☐

	positive charge	negative charge	no charge
electron	☐	☒	☐
neutron	☐	☐	☒
proton	☒	☐	☐

47.

Atoms are so small that about 10,000 billion of them could be placed on a period like the one at the end of this sentence.

Thus, if we referred to the actual mass of an atom, we would use a number such as:

.00000000000000000000002 gram

This represents the weight of one carbon atom. A carbon atom has 6 protons, 6 neutrons, and 6 electrons.

Which particle has the smallest mass?

- ☐ a proton
- ☐ a speck of dust
- ☐ an atom

a proton

48.

Protons and neutrons are approximately equal in mass, but the mass of an electron is about 2000 times less than the mass of either a proton or a neutron.

Which particles contribute most to the mass of an atom?

- ☐ electrons
- ☐ neutrons
- ☐ protons

neutrons
protons

34.

CONSIDER the total electric charge of an atom:

Since a neutron has no charge, it does not contribute to the total electric charge of an atom.

Although the charge on a proton and electron are equal in strength, they cancel one another out, because one is positive and the other is negative.

Considering that protons and electrons are always present in equal numbers and that their charges are neutralized in an atom, you can guess that an atom as a whole has:

- ☐ a negative charge
- ☐ a positive charge
- ☐ no charge

no charge

35.

Absence of an electric charge is characteristic of:

- ☐ an atom as a whole
- ☐ an electron
- ☐ a neutron
- ☐ a proton

an atom as a whole

a neutron

36.

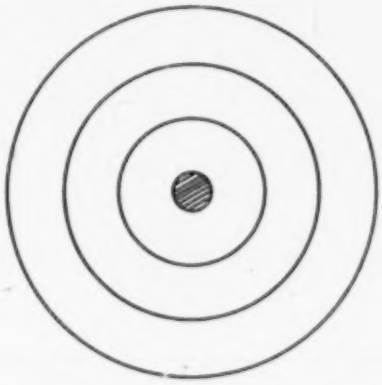
Which particles are found in the nucleus of an atom?

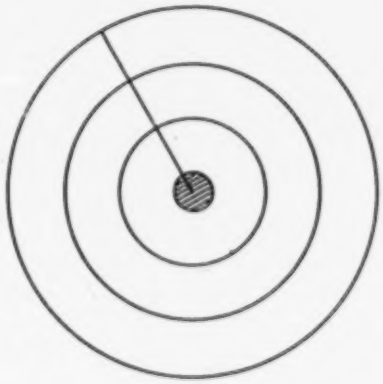
- ☐ electrons
- ☐ neutrons
- ☐ protons

neutrons
protons

46.

DRAW the atomic radius of the atom shown below:





(Or any line drawn from the center of the nucleus to the outermost orbit.)

37.

The nucleus contains only protons and neutrons. Since neutrons have no charge, and protons have a positive charge, you can guess that the nucleus of an atom as a whole has:

- ☐ a negative charge
- ☐ a positive charge
- ☐ no charge

a positive charge

Electrons have:

- ☐ a negative charge
- ☐ a positive charge
- ☐ no charge

a negative charge

38.

Since electrons have a negative charge, and a nucleus as a whole has a positive charge, you would expect that electrons in orbit around a nucleus to be:

- ☐ attracted to the nucleus
- ☐ repelled by the nucleus

attracted to the nucleus

39.

At this point you may be asking the question: If electrons are attracted to a nucleus, why don't they move toward the nucleus rather than stay in orbit?

In a previous frame we said that electrons moved around the nucleus at very high speeds. From your understanding of energy as the ability to move matter, would you say that electrons possessed energy?

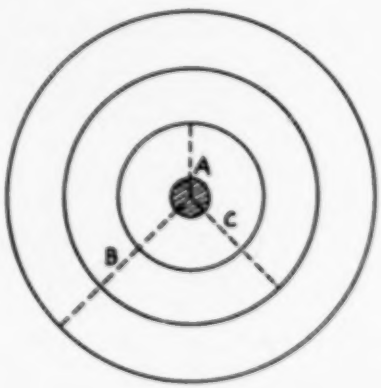
- ☐ yes
- ☐ no

yes

45.

The radius, or diameter (twice the radius), is used to calculate the size of a circle or sphere. Since scientists have theorized that the atom probably has the shape of a sphere, we also speak of the radius of an atom.

The atomic radius is the distance between the center of a nucleus and the outermost orbit of an atom.



Which line drawn in the atom above represents its atomic radius?

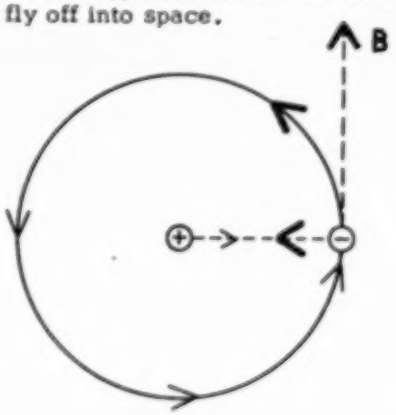
- ☐ Line A
- ☐ Line B
- ☐ Line C

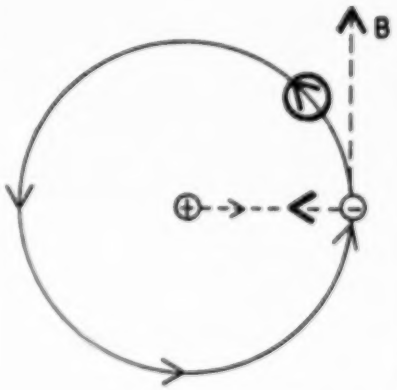
Line B

40.

The energy an electron possesses would enable it to move away from the nucleus of an atom altogether if it were not for the attraction of the nucleus. Because the nucleus is a tightly packed, positively charged core, it draws the electron toward it.

In other words, the electron's orbital path may be considered as a compromise between the attraction of the nucleus and the energy the electron has that would enable it to fly off into space.





In the diagrams above, the three arrows that are darker than the others are leading away from the electron. One arrow represents the electron's attraction to the nucleus. Another arrow indicates the direction the electron would follow if it was not attracted to the nucleus. The third arrow represents the orbital path of the electron.

CIRCLE the arrow that represents the electron's compromise:

43.

The more energy an electron has, the further away its orbit will be from the nucleus.

An atom has 2 electrons in its K orbit, 8 electrons in its L orbit, and 3 electrons in its M orbit. The electrons of which orbit are most attracted to the nucleus?

- ☐ K orbit
- ☐ L orbit
- ☐ M orbit

K orbit

Which electrons have the most energy?

- ☐ those in the K orbit
- ☐ those in the L orbit
- ☐ those in the M orbit

those in the M orbit

44.

The electrons found in the outermost orbit of an atom are:

- ☐ least attracted to the nucleus
- ☐ most attracted to the nucleus

least attracted to the nucleus

These electrons have:

- ☐ the least energy
- ☐ the most energy

the most energy

41.

Would an electron stay in orbit around a nucleus that contained only neutrons?

- ☐ yes
- ☐ no

no

Would an electron stay in orbit around a nucleus that contained only protons?

- ☐ yes
- ☐ no

yes

Would an electron stay in orbit around the nucleus if it was not attracted to the nucleus?

- ☐ yes
- ☐ no

no

42.

The charges of protons and electrons are always the same; that is, the charge of a proton will always neutralize the charge of an electron. Knowing this, you may be wondering why all the electrons of an atom do not follow the same path around the nucleus.

Which do you think is correct?

- ☐ The electrons in the second orbit of an atom have less energy than the electrons in the first orbit.
- ☐ The electrons in the second orbit of an atom have more energy than the electrons in the first orbit.

The electrons in the second orbit of an atom have more energy than the electrons in the first orbit.

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